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THE PRESENT STATUS OF HYSTEROSALPINGOGRAPHY

WITH A REVIEW OF THE LITERATURE AND A REPORT OF 512 PERSONAL CASES

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HISTORICAL SURVEY

THE first recorded attempt to visualize pelvic organs by means of the roentgen rays was made in 1914 by Cary[22] who injected the uterine cavity and the fallopian tubes with a solution of collargol and took roentgen plates of the injected organs. Cary's primary interest was in the determination of the patency of the fallopian tubes. Soon afterward, Rubin,[161] and Dartigues and Dimier[35] extended their investigations to all pelvic organs. However, on account of the marked peritoneal reaction which invariably followed whenever the collargol entered the abdominal cavity, the method soon had to be discarded. Ries,[159] after his experiences in three cases injected for the determination of the permeability of the fallopian tubes, writes:

> The three cases were perfectly clean women; all three were prepared as carefully as for any abdominal operation and the syringe was cleaned with all precautions. Nevertheless, these patients developed acute peritonitic symptoms. I have, therefore, discarded this procedure for fear I will occlude an open tube rather than open one that was occluded before.

In 1919, Stewart and Stein[199,201] introduced transabdominal pneumoperitoneum for the demonstration of the contour of the pelvic organs. Air inflation of the peritoneal cavity in conjunction with roentgen-ray examinations had previously been performed by Kelling,[112] Jacobeaus,[101] Weber,[213] Rautenberg,[156,157] and Goetze,[69] but these examinations, except those of Goetze referred chiefly to the liver, spleen and diaphragm. To Stewart and Stein belongs the credit of having applied pneumoperitoneum for the roentgenologic visualization of the pelvic organs. They[199] say with regard to this:

> In the exaggerated, lateral, Trendelenburg position (patient lying on either the left or right side in the bayonet position) we were able to demonstrate not only the normal uterus with its round ligaments, small cystic ovaries and normal bladder, but also myomatous tumors of the uterus, which, as is well known, have not heretofore been roentgenologically demonstrated.

Very shortly afterward, Rubin,[163] in 1920, published his first results (55 cases) of transuterine tubal air inflation, now universally known as the "Rubin test." Although the purpose of Rubin's procedure was "the nonoperative determination of patency of the fallopian tubes in sterility" by the

measurement of the actual pressure necessary for the inflation, the method was soon used in conjunction with roentgen examinations for the demonstration of the pelvic organs as the so-called transuterine pneumoperitoneum. Peterson,[144] who, with Van Zwaluwenburg, contributed a great deal to the perfection of gynecologic roentgenography, combined the transabdominal and transuterine gas inflation, in many cases to considerable advantage. In fact, after additional improvement, the pelvic pneumoperitoneum had become such an important method of examination that Peterson made the following statement:

> After some thirty years' experience in a special field of work, I took it for granted there was very little to be felt in the pelvis that I could not feel. I must confess that after my experiences with pelvic roentgenography my eyes have been opened to the fact that there are possibilities in relation to preoperative diagnosis I never dreamed of.

However great the advantages of pelvic pneumoperitoneum, as a whole, might have been, the impression was slowly gained that the Rubin test had not entirely solved the problem of exactly determining the patency or non-patency of the fallopian tubes. First, in some instances, the results of the inflation did not agree with the operative findings, second, in case of non-patency the exact site of the occlusion could not be determined. For this reason, attempts were made to supplement the Rubin test, especially in cases of tubal occlusion, with the intrauterine injection of opaque substances. Kennedy,[113] in 1923, used a 20 per cent solution of sodium bromide (3 to 10 c.c. under a pressure of 75 to 200 mm. mercury), and by means of roentgenograms he succeeded in demonstrating that the site of the occlusion can be accurately localized. Of 18 of his cases of non-patency, in 30.8 per cent the occlusion was found at the isthmic end of the tube and in 69.2 per cent it was found at the fimbriated end. In none of the cases was there observed any ill effect from the injection. Kennedy's method was also highly recommended by Laquerrière and Lehmann[116] who in describing the procedure reproduced one of Kennedy's roentgenograms clearly illustrating the advantages of filling the uterine cavity and the tubes with sodium bromide.

In 1925, Williams and Reynolds[214] used an emulsion of barium sulphate and bismuth (under general anesthesia) and they also were able to demonstrate "by X-ray photographs taken twentyfour, fortyeight, and seventytwo hours later" a good filling of the uterine cavity and the tubes. Schober,[184] Serdukoff[189] and others reported similar results with the use of sodium bromide, sodium iodide, etc.

Although the application of all these opaque substances represented rather important phases in the development of pelvic roentgenography, it was not until the general use of lipiodol that the problem entered the stage of its final solution. The chief reason for this lies in the fact that most of the substances used, though media of good opacity, sooner or later led to irritative changes resulting in ill effects of various degrees. Sicard and Forestier, in using lipiodol (a preparation made by L. Lafay[52] in 1902) in the form of intramuscular injections for the treatment of diseases in which a slow and prolonged iodine medication was desired, accidentally discovered that this substance, aside from the fact that it is entirely innocuous and perfectly well tolerated by the patients, casts excellent shadows on the roentgenograms. With this observation as an incentive, these authors immediately injected lipiodol for roentgenologic diagnosis, in various body cavities, and in 1921 they were able to report the successful use of the medium for the localization of epidural tumors[191] and shortly afterward[53] for the visualization of the tracheobronchial tree.

In March, 1922, before the Société médicale des hôpitaux de Paris, Sicard and Forestier[192] advocated for the first time the general use of lipiodol for the roentgenologic demonstration of all body cavities. That

this procedure was correct we see from the fact that four years later the same authors were able to report the successful use of 5000 lipiodol injections in the study of the epidural and subarachnoid spaces, the bronchopulmonary tree, cold abscesses, accessory sinuses, urethra, stomach (in gelatin capsules), and blood vessels (capillary system) without the occurrence of a single accident.

It is a rather interesting fact, however, that in spite of such a detailed investigation of the possibilities of the employment of lipiodol, no mention is made of its indication in conjunction with pelvic roentgenography. Indeed, the development of the technique of the gynecologic use of the lipiodol, the so-called hystero- or uterosalpingography, comes from an entirely different part of the world. It was Heuser, of Buenos Aires, who in 1921 obtained the first roentgenograms of uterine cavities injected by lipiodol[91,92] and who in 1924, through Case, presented at the Latin-American Congress in Lima a detailed study of the subject,[84] insisting especially on the value of the method in the early diagnosis of pregnancy. In June, 1924, Portret[150] of France, published his experiences on the "radiological researches on the visibility of the female genital organs," and on December 15, 1924, Carelli, Gandulfo and Ocampo[20] communicated their first investigations, in 7 cases of various gynecologic conditions, on the combination of lipiodol with pneumoperitoneum. These authors[20] say:

> In order that the roentgenologic exploration may be complete, it is necessary in many instances to know the exact form and volume of the uterine cavity, the capacity, form and permeability of the tubes, etc. With this object in mind, we have employed the injection of lipiodol within the uterine cavity in conjunction with pneumoperitoneum.

During 1924 casual communications appeared also by Busson and Portret,[19] who reported the value of the intrauterine injection of lipiodol in a patient with double uterus and patency of the left and occlusion of the right tube, and by Vercesi[210] who reported a case of double vagina and uterus.

During 1925, the publications rapidly increased in number. Tussau,[206] Mocquot,[128,129,130] Grégoire, Darbois and Béclère,[73,74] and Forsdike[54] were all unanimous in recognizing the great value of lipiodol in pelvic roentgenography. Dyroff[43] advocated the use of a bromide compound instead of the iodine compound because of its lesser irritability, and he[44] presented some roentgenograms illustrating the presence of "tubal peristalsis." Ferré[50] described 6 cases of uterine fibroma successfully diagnosed by the intrauterine injection of lipiodol. Heuser[87] at the First International Radiological Congress in London again insisted on the value of the method in early pregnancy and he laid down "fixed rules for the diagnosis of pregnancy after a woman missed one or two periods."

A careful review of the literature since 1926 reveals that the number of articles dealing with various phases of the gynecologic application of lipiodol reaches now into the hundreds. It is impossible to give a detailed account of all of these articles here, but we should like to mention the works of McCready and Ryan,[120] Cotte and Bertrand,[28] Oumansky,[143] Newell,[139] Bakke,[7] Temesváry,[204] Centanaro,[24] Romero,[160] Nahmmacher,[138] and especially of Jarcho[102,103,104] as the most outstanding.

Stein and Arens,[196,197] and Jung and Schirmer[110] reported on the combination of hysterosalpingography with pneumoperitoneum, while Heuser[89] and Claude Béclère[14] each wrote a textbook; the former on "The Radiography in Gynecology, Obstetrics and Urology," and the latter on "The Radiologic Exploration in Gynecology, its Technic and Results."

THE VARIOUS CONTRAST MEDIA AND THEIR USE

The number of the substances utilized as contrast media since the introduction of hysterosalpingography in 1914 is rather

large. Cary,[22] Rubin,[164] Dartigues and Dimier,[35] Ries,[159] and others, as already mentioned, used aqueous solutions of collargol, while Kennedy,[113] Schober,[184] Kok,[115] Fraenkel,[56] Serdukoff,[189] Nölke,[140] De Baker,[36] and others, employed, and some still employ, aqueous solutions of sodium bromide.

The different barium emulsions used are: barium and bismuth, by Williams and Reynolds[214]; barium sulphate and sodium bromide, by Gibbons[68] and barium sulphate bougies (with petrolatum and oil of theobroma) by Hirsch.[96]

Jaroschka[105,106] and Hellmuth[81] used an aqueous solution of lithium iodide, the so-called "umbrenal."

Of the many oily solutions, lipiodol (40 per cent) and iodipin (20 per cent and 40 per cent) proved by far the most satisfactory and they are utilized now by the majority of investigators. However, mention should also be made of a bromide oil, "contrastol" (10 per cent and 25 per cent), introduced by Dyroff,[43,45] of "radiopol" (25 per cent) used by de Grisogono and Gortan[37] and of "lipoiodin" applied by Bertrand, Villemur and Baillat.[17]

More recently a new brominized oil (lard oil containing 40 per cent bromine) has been advocated by Putnam[153] and a rape-seed iodized oil ("campiodol") by Frazier[62] and Frazier and Glaser,[63] but although both were found "the most satisfactory" in cerebrospinal visualization and pneumography, none of them have as yet been tried in uterosalpingography.

In our series, the French lipiodol was used, which is a preparation containing 0.54 grams iodine to the cubic centimeter of poppy seed oil. If fresh, it is yellowish and transparent and has much the appearance of olive oil. On account of its high iodine content, it is thoroughly impervious to roentgen rays. Its oil component insures a perfect tolerance and very slow absorption, and its continuous presence without any ill effects in various locations of the body has been reported. Moreover, it is self-disinfecting and mildly germicidal, two factors which, as we shall see, are very important from the point of view of the more recent therapeutic applications of hysterosalpingography.

In analyzing the relative advantages of the above contrast media, our attention must be directed, in the first instance, to the deleterious effects which might result from their practical application in uterosalpingography. As we have already seen, the use of collargol and sodium bromide soon had to be abandoned because of their very irritating action on the peritoneum. But a careful review of the literature dealing with the untoward reactions produced by other injected media will reveal that they, too, are not altogether without harm. Hellmuth[81] reported the accidental death, six days following the injection, of a patient who received only 3 c.c. of umbrenal, and at the post-mortem examination evidence of streptococci was found in the left tube. Haselhorst[79] published 3 cases in which there was severe infection following the injection of iodipin; the first case that of an ovarian cyst which at subsequent operation showed "extensive sterile inflammatory reaction," the second case that of a pregnancy where the contrast medium was injected for therapeutic abortion and where infection followed (resulting in placentar remnants, which later were successfully removed), and the third case that of a chronic bilateral salpingitis, which thirteen days later led to exacerbation of the infection. Odenthal[142] likewise reported 2 cases of infection, one following the injection of contrastol and the second following the injection of iodipin. "Acute infections of the uterus and tubes" were described by Hoffmann[98] in one case, and by Mandelstamm [121] in 2 cases, one of his own (out of a total of 34 cases) and one observed elsewhere. Recently Gauss,[65] in tabulating the results in about 3000 cases of hysterosalpingography (chiefly with iodipin), found that death had occurred in 5 cases (0.11 per cent) and infection in 13 cases (0.43 per cent).

Ill effects from the use of lipiodol were reported by Rubin[170] who in a series of 66 cases observed subsequent abscess formation in 2 cases and peritoneal irritation in 3 cases. Hirst[97] reported an accidental death following the injection of lipiodol. In this case, operation was performed twenty-four hours after the test and streptococcic infection of the tubes was found. Of the 80 cases of Mathieu's[122] there was an elevation of temperature (101°F.) in one case lasting for a period of twelve hours.

Béclère,[13] in 1928, after analyzing the results of 750 cases of various pelvic conditions injected with lipiodol in France (150 cases from Mocquot and Bureau,[132] 150 cases—later 200 cases[26]—from Cotte,[33] 120 cases from Francillon-Lobre and Dalsace,[57] 123 cases from Le Goff[117] and 200 cases of his own), found that not one single accident or ill effect was reported, and therefore arrived at the conclusion that lipiodol is absolutely innocuous and consequently a preparation which should be used in preference to all other iodized oils. This conclusion was also reached by van der Elst and Gautot[207] who likewise failed to observe a single accident in a series of 150 cases. Temesváry,[204] after making comparative studies with umbrenal, iodipin and lipiodol, found that the reaction produced was most pronounced with umbrenal, only moderate with iodipin and absolutely nil with lipiodol. For this reason, he, too, advises the exclusive use of lipiodol in all cases of uterosalpingography.

More recently, however, even Béclère (in collaboration with Lecène and Tedesco[118]) and Sicard and Solal[195] observed the exacerbation of old infections following intrauterine injection of lipiodol. Béclère, whose case constitutes his first accident in a series of 230 cases, believes that the ill effect was due to the fact that the injection of the lipiodol was undertaken too near the menstrual period and he therefore advises that one should wait until at least eight days after menstruation. The same conclusion is reached by Douay[41] who likewise noticed the exacerbation of an infection in a case in which the injection was performed too close to the menstrual period.

In our series, which includes 512 cases of pelvic injections, the only accident observed was that of a ruptured tube, which occurred in a woman with bilateral hydrosalpinx (Fig. 28). The rupture was accidentally discovered the following day at the operation, and apparently had produced no ill effects.

PROCEDURE

It is obvious from the above that a very careful selection of patients submitted for hysterosalpingography is essential. Cases of recent hemorrhage, inflammatory conditions that are not completely quiescent, active infections or malignancies involving the cervix, ectopic gestations or uterine gestation in which a therapeutic abortion is not desired, infected cervical or uterine polyps, fever, etc., are absolute contraindications. Our group of cases represents both hospital and ambulatory patients, the greater number being ambulatory. All of the latter were allowed to return home immediately following the completion of the examination and in none of these cases were there any untoward effects.

For the reason already given, the most suitable time for pelvic hysterosalpingography is one week following the menstrual period. At this time, the injection produces the least discomfort and subsequent infections are avoided.

The preparation of the patient consists in the adminstration of cathartics and vaginal douches the day previous to the examination. The douche is repeated the next morning and at this time an enema is also given.

We have not found it necessary to prescribe opiates or antispasmodics prior to the injection, though in selected cases such a procedure may be of value. The discomfort produced by the actual injection is so slight that in no case of our series was there evidence of the slightest irritation except,

of course, the mild cramps due to the distention of the uterine cavity and oviducts by the opaque medium, which subsides as soon as the injection is completed and the pressure released.

TECHNIQUE

The contributions to the technique of injection of lipiodol in hysterosalpingography are very numerous. Various methods, apparatus and manometers were described by Portret,[150] Mocquot[128,132] Cotte,[25,28] Béclère,[9,10,11,14] Dyroff,[46] Jarcho,[103,104] Isar,[100] Centanaro,[21] Adler,[2] Petit-Dutaillis,[145] Francillon-Lobre and Dalsace[58] Tieri,[205] D'Istria,[39] Fernández,[49] Adair and McDonald,[1] Stein and Arens,[198] Rubin and Bendick,[172] and others.

FIG. 1. Showing technique of injection.

The technique of all these investigators can be reduced to two basic principles: (1) the injection of the opaque substance under carefully controlled pressure in a "closed cervix," and (2) the injection of the contrast medium under its own pressure in "an open cervix." While both methods have their advantages, there can be no doubt that the controlling of the pressure during the injection in a "closed cervix" is by far the simplest and safest.

This method which is used also by us is, in general, as follows: The patient is prepared as for any vaginal operation and placed in the Sims position on a roentgen-ray cystoscopic table provided with a Bucky grid (Fig. 1.). The cervix is exposed, swabbed with iodine, drawn into view by a tenaculum and held quite firmly in position. A 10 or 20 c.c. Record syringe, to which has been attached a suitable cannula on which has been placed a tightly fitting rubber olive of proper size to act as a plug in the cervix, and a speculum suited to the case to be injected, are the only instruments necessary for the injection. The cannula is inserted into the cervix of the uterus until the rubber olive is in contact with the external os, and with gentle traction on the tenaculum and firm pressure on the syringe the olive is pressed into the cervix so that it prevents the escape of the lipiodol into the vagina. The lipiodol which has been warmed to a temperature of approximately 105°F. is injected very slowly, using only sufficient pressure upon the piston to move the column of oil perceptibly. After the injection of 1 or 2 c.c. of lipiodol, the patient usually complains of a cramp, of mild severity, in the lower abdomen, which is due to filling of the uterine cavity and its partial distention. At this point it is necessary to watch very carefully to see if there is a slight rebound of the piston, which is an indication of filling of the uterine cavity. After a few minutes' wait, further injection is attempted, but if the rebound persists, the injection may be considered complete. The amount of oil necessary to inject the normal uterus and oviducts varies from 2.5 to 5 c.c., the average being about 4 c.c.

We concede that a manometer so arranged as to register the amount of pressure exerted would be desirable, but so far we have not found one which we consider entirely satisfactory. Furthermore, after a

few injections, one acquires a sense of resistance on the piston of the syringe, which is, we believe, a satisfactory indication of the amount of pressure being exerted.

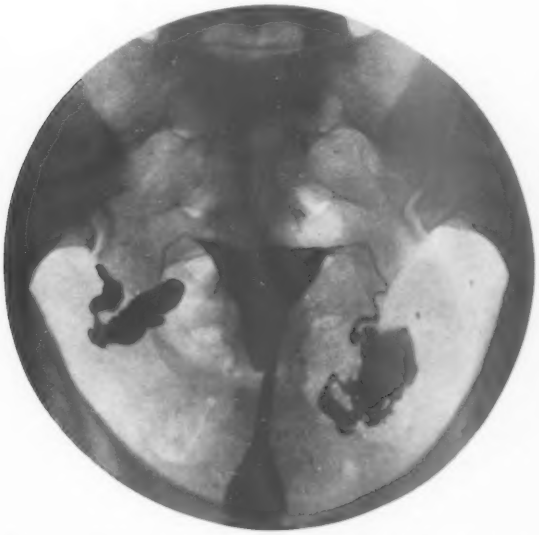

Fig. 2. Normal uterine cavity with both tubes patent. Free lipiodol in the left pelvis.

Fig. 3. Normal uterine cavity with both tubes patent. Droplet distribution of the lipiodol in the pelvis.

Having completed the injection, the excess of oil is gently wiped from the cervix and the vaginal wall (Fig. 7), the speculum is removed from the vagina and roentgenograms are taken. It is important that during the actual exposure the syringe and tenaculum be carefully held so as not to change the normal relation of the uterus in the pelvis (Fig. 6).

Stereoscopic roentgenograms are taken as a routine procedure, but in some instances exposures in the lateral and oblique positions are also made. If there is evidence of occlusion of the tubes, or if a functional study of the pelvic organs is desired, subsequent roentgenograms are taken at different intervals for a period of twenty-four hours. In the case of functional study of the fallopian tubes, the injection of the contrast medium under roentgenoscopic control is occasionally of great advantage.

A very detailed study of the normal appearance of the pelvic organs following hysterosalpingography was made by Reinberg and Arnstam[158] and by Rubin and Bendick.[172]

Briefly, the oil-injected, normal uterine cavity casts a shadow roughly triangular in shape, the apex of which represents the cervical portion, and the base the fundal portion of the uterus (Figs. 2 and 3). The proximal portion of the normal oviduct casts a fine, almost hair-line shadow, which increases in diameter as the fimbriated portion of the tube is outlined. In our observations, we have not found the position of the tubes to be constant, but in the majority of instances they assume a position lateralward from the cornua of the uterus. At the cornual attachment of the tube a distinct ring-like constriction can usually be made out which is believed to represent a structure analogous to the pylorus in the stomach (Fig. 17). This constriction has been proved histologically to represent a true sphincter, the function of which is still open to discussion. Oil which has escaped through the fimbriated end of the tube and is free in the pelvis casts small, smooth, globular shadows which are readily differentiated from the shadows cast by the oil still present in the tubes. Excessive

quantities of lipiodol are undesirable, as the massed oil casts shadows which are extremely confusing (Figs. 4 and 5), and in many instances may obscure important

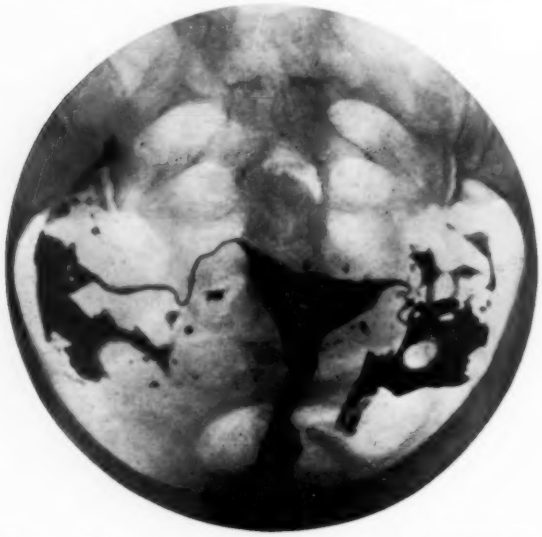

FIG. 4. Normal uterine cavity with both tubes patent. Excessive quantity of oil in the pelvis producing confusing shadows.

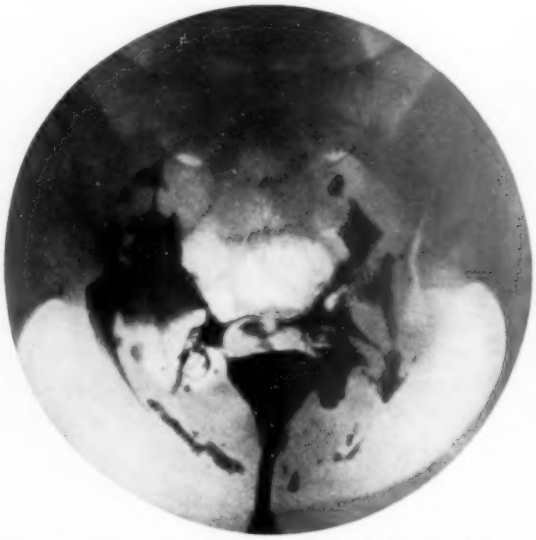

FIG. 5. Normal uterine cavity with both tubes patent. Excessive quantity of oil and movement during exposure.

changes in the adnexa or adjacent structures, which could have been demonstrated if only a sufficient quantity of oil to properly inject the uterus and oviducts had been used.

THE ACCIDENTAL INJECTION OF THE UTERO-OVARIAN VENOUS SYSTEM

It is interesting to know that in some instances the intrauterine application of lipiodol may result in the injection of the venous system of the pelvic organs leading to an escape of the contrast medium into the general blood stream. Fortunately such an occurrence is entirely harmless and without any clinical significance.

The first to call attention to the possibility of "the escape of foreign material from the uterine cavity into the uterine veins" was Sampson[177] who in 1918, after injecting extirpated uteri with bismuth or barium suspension (in gelatin) demonstrated that "foreign material can often be easily forced from the cavity of the uterus into the uterine veins if the endometrium is injured or has been removed by curettage. A study of the uterus in which the veins have been injected, demonstrates large receiving sinuses radiating from the base of the endometrium into the myometrium. If these sinuses are exposed by removing the overlying endometrium and the uterus is relaxed, thus holding the lumina of the sinuses open, fluid and small solid material could easily escape from the uterine cavity into them when the pressure in the uterine cavity is greater than that in the sinuses."

In 1923, Sicard and Forestier[193] injected lipiodol directly into the blood stream of dogs in order to determine if there is any deleterious effect, and especially if there is fatty embolism due to distribution of the lipiodol in the vascular system. As a result of repeated and painstaking roentgenoscopic examinations, it was found that if the injection is made into the femoral veins, the lipiodol (after pulverization in the heart) rapidly reaches the pulmonary capillaries, where, after a period of ten or twelve minutes, it suddenly disappears. However, if the injection is made into the portal vein, the absorption is considerably slower, and

it takes several hours for the lipiodol to entirely disappear from the blood stream. Finally, if the injection is made into the arteries the absorption is the fastest

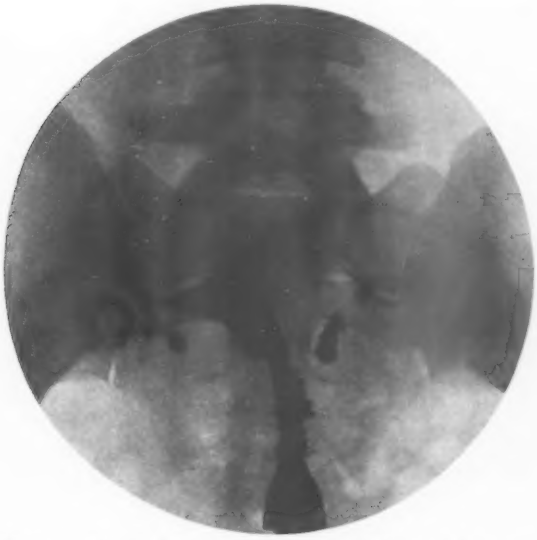

Fig. 6. Normal uterine cavity with both tubes patent. Displacement of uterus to the left as the result of instrumentation.

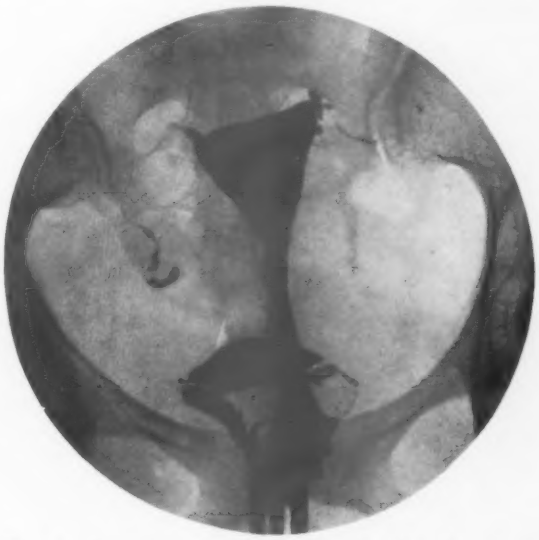

Fig. 7. Apparent occlusion of both tubes due to reflux of oil in vagina as result of improper fitting of the olive in the cervix.

(through the peripheral capillaries). Finding such an intravascular injection of the lipiodol harmless in animals, Sicard and Forestier[193] repeated the experiments with humans. Two to 4 c.c. lipiodol was injected very slowly into the cubital vein (the actual time of injection being five minutes) and the absorption of the lipiodol observed roentgenoscopically. Within five to six seconds, the lipiodol had already reached the pumonary capillaries where it remained in the form of small droplets for a period of six to eight minutes after which it suddenly disappeared. Within ten minutes after the injection, the entire amount of lipiodol was absorbed. The only symptomatology manifested by the patient during this time was a very slight cough without dyspnea. As a result of these experiments, Sicard, de Gennes and Coste[190] soon afterwards utilized iodized oil in humans for the localization of the obliteration of arterial thrombosis. In 2 cases, the lipiodol was injected just above the suspected thrombotic areas (in one case with gangrene of both feet, 1 c.c. in each femoral artery and in one case with arterial obliteration of the left upper extremity, 2 c.c. in the left axillary artery) and the site of the obliteration was accurately located.

In 1926, Béclère[9] injected extirpated uteri with lipiodol at different pressures (as high as 500 mm. Hg) and found, as did Sampson, that if the endometrium is injured or if the pressure is exceedingly high, the contrast medium may enter the uterine capillaries and the uterine venous system.

In November, 1927, Pujol y Brull, Vanrell and Carulla Riera[152] for the first time presented before the Sociedad de Chirurgia de Barcelona the "accidental injection of the utero-ovarian venous system in the course of hysterography in the living." These authors were able to secure a number of roentgenograms showing the injection of the peri-uterine venous system; moreover, in one of their cases, the entire length of both utero-ovarian veins was outlined by the contrast medium. After numerous experiments on cadavers (by injecting the venous system both by the intrauterine and retrograde way) they ar-

FIG. 8. Accidental injection of utero-ovarian venous system during hysterosalpingography.

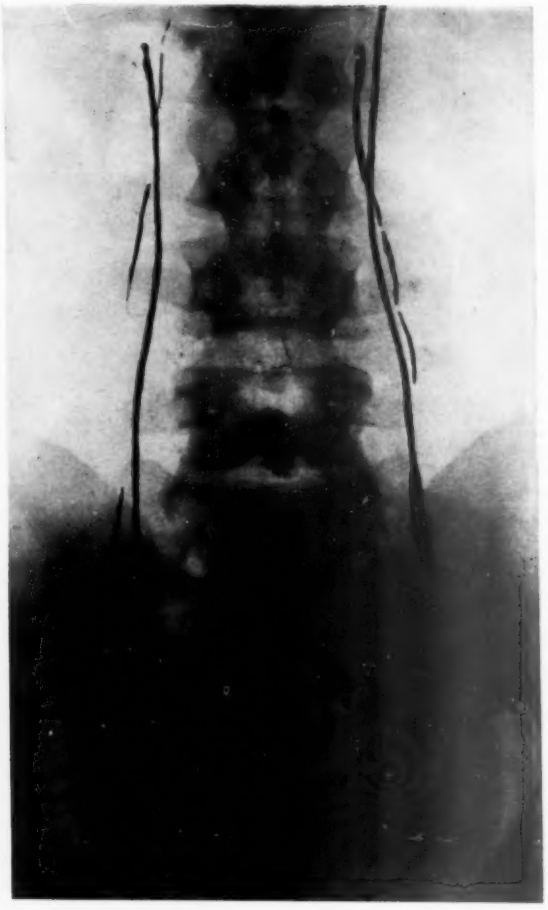

FIG. 9. Same as Figure 8. A second attempt at hysterosalpingography combined with catheterization of both ureters ten days later resulted in the same accidental injection of the utero-ovarian venous system.

rived at the conclusion that "vascular injection is the result of two mechanisms: (1) of the submucous injection due to a faulty use of the cannula, and (2) of the injection under a pressure greater than that which can be supported by the endothelium of the uterine vessels."

We have observed the accidental injection of the utero-ovarian venous system in 2 cases. In one of these cases (Fig. 8) an outlining of the peri-uterine venous plexus as well as of the entire course of both utero-ovarian veins was obtained during the use of lipiodol for a uterine condition. Since there were no untoward effects from the absorption of the lipiodol into the blood stream, we repeated the examination ten days later, at this time in conjunction with catheterization of both ureters, being very careful not to apply too much pressure or injure the endometrium during the course of the instrumentation. The result of the examination was the same (Fig. 9). Besides an extensive injection of the peri-uterine plexus, there was also an outlining of the left utero-ovarian vein as far as its entrance into the left renal vein (level of the kidney pelvis as indicated by the tip of the catheter) and of the right utero-ovarian vein as far as its entrance into the inferior vena cava (just a little above the right kidney pelvis).

Fig. 10. Injection of extirpated uterus with lipiodol under increased pressure showing entrance of the opaque medium into utero-ovarian venous system.

Fig. 11. Same as Figure 10, with practically normal pressure.

Since in our case a repetition of exactly the same phenomenon was obtained ten days later, and since at the second examination only a very slight pressure was used, it seemed to us that in addition to the two above causes of accidental injection of the venous system during hysterography, as mentioned by Pujol y Brull, Vanrell and Carulla Riera, there must also be a third cause, most probably an increased permeability of the "receiving sinuses," such as is observed in idiopathic uterine bleedings. A number of injections on extirpated uteri (Figs. 10 and 11) convinced us that in some instances a very slight pressure indeed is sufficient to produce an extensive injection of the entire utero-ovarian venous system.

PRACTICAL APPLICATIONS OF HYSTEROSALPINGOGRAPHY

Hysterosalpingography is of great diagnostic value in developmental anomalies of the genital organs, in tubal affections leading to sterility, in certain very carefully selected cases of pregnancy in which therapeutic abortion is indicated or where a differential diagnosis from other obscure conditions is essential, in uterine tumors, excepting malignancies, and in certain extra-uterine tumors.

Developmental Anomalies. The value of hysterosalpingography in the diagnosis of developmental anomalies of the pelvic organs has been repeatedly emphasized. In fact, some of the earliest reports on the practical application of the injection of lipiodol, as, for example, the cases of Busson and Portret,[19] Vercesi,[210] and others, are descriptions of such conditions.

In conjunction with developmental anomalies, hysterosalpingography may be used for the visualization of changes in position, size and shape of the uterine cavity. The changes in position of the uterine cavity, which as a rule are due to malpositions of the uterine body as a whole, are recognized in the majority of cases by clinical examina-

FIG. 12. Anteflexion of the uterus with bilateral occlusion of the tubes.

FIG. 13. Same as Figure 12, lateral view.

tions, consequently their demonstration by means of injection of contrast media (Figs. 12 and 13) is of purely academic interest. Not so, however, the changes in size and shape. Here uterosalpingography is often of the greatest help, especially if one considers that a surprisingly large number of sterilities are due to developmental anomalies of the uterus. This point will be further analyzed when discussing the causes of sterility in connection with tubal roentgenography.

The developmental changes in size are due chiefly to infantile uteri (Figs. 14, 15, 16 and 17). These uteri cast a small triangular, or less frequently (Fig. 17) a bicor-

FIG. 14. Infantile uterus with occlusion of both tubes.

FIG. 15. Same as Figure 14, lateral view.

Fig. 16. Infantile uterus with occlusion of both tubes.

Fig. 17. Bicornate uterus with occlusion of both tubes. Evidence of sphincter rings of the cornual ends of the tubes.

nate-like shadow which occasionally is so small that 0.5 c.c. iodized oil is entirely sufficient to fill the cavity. The changes in shape are represented mainly by the bicornate uteri (Fig. 18) which occur more frequently than heretofore supposed. The roentgenologic appearance, following the injection of the contrast media, in these cases is so typical that it seems unnecessary to enter into a more lengthy discussion of the subject. In one case, we have observed a double uterus, with two distinct cavities and two separate cervices (Fig. 19). Although the condition could readily be determined by bimanual examination, hysterosalpingography gave the additional

Fig. 18. Bicornate uterus with occlusion of right tube.

Fig. 19. Double uterus.

FIG. 20. Menstrual fistula.

information that both uterine cavities were rather small and that each had but one tube which was patent. It is of interest to note that this patient, who suffered from sterility for many years, became pregnant shortly following the injection of the lipiodol and delivered a normal baby.

We should also like to include in this group a case of an acquired anomaly, that of a menstrual fistula. Ballin[8] recently wrote an excellent article on this subject and therefore we would like to refer those interested to that publication. Here, we wish only to mention that the injection of lipiodol is of considerable aid in accurately outlining the course of the fistula and thus establishing definite surgical indications (Figs. 20 and 21).

Tubal Affections Leading to Sterility. The most, frequent and, one may say, the most important gynecologic use of lipiodol is in connection with certain tubal affections leading to sterility. Here roentgenography may be of aid for four reasons: (1)

FIG. 21. Specimen of the menstrual fistula removed at operation.

in the absence of palpatory findings it leads to definite diagnosis in many obscure conditions of the fallopian tubes; (2) it permits the study of the peristalsis of the tubes which is not possible by any other method of examination; (3) in many instances it leads to direct therapeutic results, and (4) it permits, in well-selected cases, the differentiation of chronic salpingitis from chronic appendicitis.

Cary,[22] Rubin,[164,165] Kennedy,[113] Williams and Reynolds,[214] Schober,[184] and others,

injected various substances into the uterus and oviducts for the purpose of determining the type and cause of tubal pathology in sterile women. Aside from the congenital malformations and malpositions of the uterus, these workers paid special attention to the patency or non-patency of the fallopian tubes. However, on account of the irritative character of the substances used, they had to limit the practical application of their method to the strictest minimum. Only after the introduction of lipiodol, due to the excellent roentgenographic qualities of this substance, did salpingography become a routine method of examination. Indeed, since then there is practically no article dealing with hysterosalpingography which does not emphasize in some form the value of lipiodol in sterility so that a detailed review of the literature would simply mean an enumeration of all articles written on hysterosalpingography.

The authors who have made "the demonstration of the patency or non-patency of the fallopian tubes by means of lipiodol" their special study are likewise numerous. Thus Heuser[85,90] Grégoire, Béclère and Darbois[73,74,75] Cotte and Bertrand,[29] Fraenkel,[55] Henkel,[82] Rubin and Bendick,[171] Randall[154,155] Mikulicz-Radecki, Lueg and Nahmmacher,[125] McCready and Ryan[120] Vercesi,[209] Nölke,[140] Jarcho,[102] Douay,[40] Rosenblatt and Kass,[163] Temesváry,[203] Francillon-Lobre and Dalsace,[59] Bakke,[5] Miller and Henderson,[127] Lüttge,[119] Saidl,[176] van Ebbenhorst Tengbergen,[208] Seidler,[188] Stone,[202] Dellepiane,[38] Iribarne and Capizzano,[99] Fodor,[51] Centanaro,[24] Schultze,[185] Béclère,[12] and Rubin[168] (650 cases), contributed a great deal toward the solution of the problem of salpingography. Schmitz,[179] who recently made an excellent study on "the diagnosis and treatment of sterility due to diseases of the fallopian tubes" sums up the present status of salpingography as follows:

1, peruterine tubal air inflation is used to test, in the absence of palpatory findings, the patency or non-patency of the tubes, if potency of the male partner has been assured and the patient is desirous of offspring. 2, salpingography is used to locate the site of obstruction. The operative methods to be used can thus be determined before operation. 3, during operation the patency or non-patency of the tube may be tested with peruterine gas inflation through the cervix, and after operation the results of salpingostomy, tubal resection, and implantation may be investigated by gas inflations repeated at ten day intervals.

While, in general, we agree with the above statements of Schmitz, there are, nevertheless, instances in which hysterosalpingography, as Jarcho[103] says, "not only supplements but supplants insufflation of gases." This is clearly evidenced in the following case, which is cited merely as an example of what might happen.

A woman, thirty-nine years of age, came for a consultation as to the cause of her sterility. Bimanual examination revealed no palpable pathology, though a deep pelvis and firm panniculus precluded the possibility of a satisfactory palpation of the fundus. The Rubin test on two successive occasions showed both tubes to be patent. Thus, since her husband's secretion showed viable spermatozoa on three different occasions, no cause for her sterility could be demonstrated. The injection of lipiodol then gave the necessary information. There was an extremely small infantile uterus with both tubes patent. We are of the opinion that probably this condition might have been discovered by careful examination under anesthesia, yet the roentgenograms offered such decisive proof that the cause of sterility was established at once.

On the other hand, it has been observed that not infrequently cases in which tubal occlusion had been diagnosed by the Rubin method were found to have patent tubes when injected with lipiodol. That a repetition of the Rubin test in such instances might have led to a satisfactory demonstration of the patency of the tubes is granted, yet the results of lipiodol injection are, in our experience, more constant and afford a means of presenting concrete evidence of demonstrable pathology.

FIG. 22. Bilateral tubal occlusion at the cornual ends.

FIG. 23. Bilateral tubal occlusion at the cornual ends.

Salpingography, by means of lipiodol or other iodized oils, is, therefore, superior to tubal insufflation: (1) in all cases with patency of the fallopian tubes where the Rubin test or the palpatory findings have failed to furnish satisfactory explanation of the cause of sterility, and (2) in cases of nonpatency of the fallopian tubes, for the determination of (*a*) whether the occlusion of the tubes is unilateral (Figs. 26 and 27), or bilateral (Figs. 22, 23, 24 and 25); (*b*) whether the occlusion is at the uterine end (Figs. 22, 23, 24 and 25), or at the fimbriated end (Fig. 29), or at any other point of the fallopian tube (Fig. 26), and (*c*) whether the occlusion is simple or asso-

FIG. 24. Bilateral tubal occlusion at the cornual ends. Irregularity with small filling defects of the cervix due to polyposis.

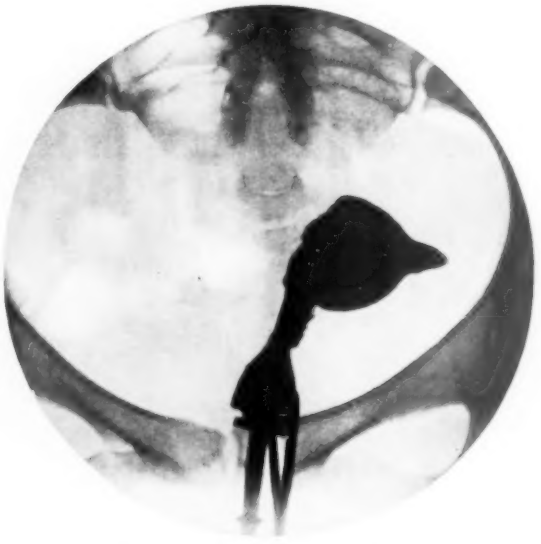

FIG. 25. Bilateral tubal occlusion with displacement of the uterus due to adhesions.

Fig. 26. Occlusion of the left tube at the fimbriated end and occlusion of the right tube distal to the cornual end.

Fig. 27. Occlusion of the right tube at the cornual end. The left tube is patent.

ciated with definite pathological condition of the pelvis (chronic salpingitis, hydrosalpinx, etc.) (Fig. 29).

In connection with the patency of the fallopian tubes certain investigators believe that a study of the oil entering the peritoneal cavity could be used for the estimation of the width of the fimbriated end of the tube. Thus large droplets would mean dilatation, small droplets stenosis, and irregular patches adherence of the fimbriated end of the tube to some bowel coils. Schultze[186] and Popovič[147] made rather extensive studies on this subject and they arrived at the conclusion that the study of the "oil-formations," together with a roentgenoscopic examination of the peristaltic motions, is of certain advantage in diagnosing conditions pertaining to changes in the width of the lumen of the fallopian tubes.

Without wishing to appear too dogmatic, we, too, believe that a closer scrutiny of the abdominal end of the tube often guards against possible errors. This is especially true in partial occlusion (due to adhesions) and stenosis of the tube. More than once have we observed that lipiodol entered the peritoneal cavity within twenty-four hours following the injection, whereas films taken immediately after the injection showed apparent closure of both tubes. We therefore cannot emphasize strongly enough the necessity of taking serial roentgenograms at different intervals following the use of lipiodol in all cases of non-patency of the tubes.

It should be mentioned here that salpingography may also be of value in rechecking the results of operation for sterility, as, for example, salpingostomy, resection of the isthmic portion of the uterine tube, tubo-uterine implantations, etc. Schmitz[179] presents some striking roentgenograms illustrating the value of such a procedure. In one of his cases, while previous to operation there was a complete occlusion of the tubes, "after implantation of the left tube and opening of the abdominal ostium of the right tube" permeability resulted. Cotte and Bertrand[30] likewise noted patency of the tubes in 3 cases following "tubo-uterine implantations," while in the 3 cases of Rosenblatt[162] the tubes, in spite of the Alexander-Adams operation, remained closed. The value of hysterosalpingography in controlling the operative

results in sterility is stressed also by Henkel,[82] Nahmmacher,[138] Samuel,[178] and others.

The second advantage of salpingography —though merely of scientific interest—is that it permits the study of the peristalsis of the tubes. Kennedy[114] in 1925 demonstrated by roentgenograms taken after the injection of a 20 per cent solution of sodium bromide the existence of an "isthmospasm of the fallopian tubes" as a possible cause of sterility. Dyroff[44,47] shortly afterwards presented roentgenograms, illustrating, with contrastol, constrictions which had every appearance of being due to "peristalsis." Heuser[88] described in detail a sphincter which he observed at the uterine end of the tube and which greatly resembled the pylorus of the stomach. Rubin and Bendick[166] noted three types of motion, while Schneider and Eisler,[181] Arnstam and Reinberg,[3] and Giavotto,[67] made further reports on the tubal "sphincter." Giavotto accidentally noticed in a case the passage of the injected lipiodol through the tube into the abdominal cavity with no filling of the uterus. From this he concluded—and this was observed also roentgenoscopically—that the passage of the lipiodol through the tube was due to periodic contractions of a sphincter near the uterine end of the tube rather than to the actual pressure exerted at the time of the injection. These periodic contractions he called antiperistaltic movements. Further studies on "tubal sphincter" and "peristaltic movements" were made by Jarcho,[103] and Joachimovits,[108] while "the intramural and isthmic portion of the fallopian tubes with special reference to the so-called isthmospasm" was investigated by Rubin[167,169], in one of the articles [167] with gas inflation and the kymograph. Hirsch,[96] in a recent communication, brought forth rather convincing evidence in favor of "tubal peristalsis." He has shown that barium sulphate suspended in a suitable oil or jelly, when inserted into the cervix in the form of a bougie, soon liquefies, and in twenty minutes following its insertion enters the tube, and in from one to two hours, the peritoneal cavity. This would tend to disprove the necessity of positive pressure as an essential aid in the progress of the opaque substance through the lumen of the tubes, and strongly suggests that uterine contractions may be a factor in propelling foreign substances into the tubes, and that tubal peristalsis is a factor in its progress through the tubes. Bakke[4,6] reports that in doing an appendectomy on a patient, he deliberately injected lipiodol into the opening at the fimbriated extremity of the tube, but was unable to show that any of the oil entered the uterine cavity. On the contrary, the lipiodol was ejected into the peritoneum in a manner similar to that described by Giavotto[67] or observed by Hirsch.[96] Bakke continued his investigations by placing lipiodol in the uterus and by observing its emptying both towards the peritoneum and into the vagina. He found that a uterus with normal tonus empties its content both ways within six to eight minutes (normokinesis), while a hypertonic uterus (salpingitis, vagotonia) empties so rapidly that unless the injection is made during the actual exposure no roentgenogram can be taken (hyperkinesis) and a hypotonic or atonic uterus (pregnancy, bleeding, endometritis, carcinoma, polyposis) empties so slowly that it takes several days for the emptying to be completed (hypokinesis). Further observations on the contractility of the uterus and tube were made by Gosset, Ledoux-Lebard and Béclère[70] and by Petit-Dutaillis and Sorel.[146]

The third advantage of the injection of the lipiodol for salpingography is in connection with its not infrequent therapeutic effect. Indeed, one repeatedly finds in the literature the description of tubal occlusions, especially in sterility, which after one or several diagnostic injections of lipiodol, have become patent. Thus Jarcho[103] describes a case of bilateral occlusion of the fallopian tubes which, at a re-

examination ten months later, showed an entirely normal picture. Samuel[178] reports 4 cases of tubal occlusion (with sterility) in which the tubes were opened by the forceful application of a 25 per cent sodium bromide solution under a pressure of 180–210 mm. Hg (the author advises that 210 mm. Hg should never be exceeded). Brooks[18] mentions 3 cases of sterility which, following a diagnostic application of hysterosalpingography, have become pregnant, two coming to full term and one terminating in abortion.

Further cases of pregnancy following diagnostic salpingography were reported by Bendick,[16] 2 cases; Douay,[40,42] 4 cases; Grégoire, Béclère and Darbois,[76,77] 2 cases; Francillon-Lobre and Dalsace,[60] 2 cases, later[61] an additional 6 cases; Rucker and Whitehead,[173] one case, and Nahmmacher,[136] several cases, while Heuser[93] says this: "Thanks to the roentgenologic visulization of the tubes, 30 per cent of the sterile women submitting to examination and treatment, have fulfilled their wish to bear children."

A fourth field where salpingography might be of considerable value is in connection with the diagnosis of certain forms of chronic salpingitis and especially their differentiation from chronic appendicitis. Carelli, Gandulfo and Ocampo[20] in 1924 described a case of cystic salpingitis, in which diagnosis was made by a combination of pneumoperitoneum and hysterosalpingography. Giavotto[66] reported the successful use of lipiodol injection in 31 cases of chronic salpingo-ovaritis (out of a total of 56 cases examined), while Cotte and Bertrand[31,32] used the method in more than 50 cases of acute and subacute inflammations of the fallopian tubes, and Darbois and Béclère[34] added 30 cases of chronic inflammations (out of a total of 100 cases). The diagnostic value of hysterosalpingography in chronic inflammations of the adnexa was emphasized also by Schultze,[187] Castronovo[23] and Newell[139] these latter insisting especially on a possible differentiation from chronic appendicitis. Gosset, Ledoux-Lebard and Béclère[71] reported 3 cases of hydrosalpinx "à soupape" and Lecène, Tedesco and Béclère[118] 10 cases of hydrosalpinx "clinically not previously demonstrated," in which a successful diagnosis was made with the aid of lipiodol.

It is interesting that although the above authors observed no ill effects from the application of hysterosalpingography in inflammations, such effects were described by Haselhorst,[80] Hellmuth[81] and Odenthal,[142] who advise great caution in the use of the method even in quiescent forms, since it may lead to exacerbation of the infection. A recidivation of an old chronic inflammation was noted in one of the cases of Lecène, Tedesco and Béclère[118] (resulting in bilateral pyosalpinx) and in a similar case of Douay.[41]

Roentgenologically, chronic salpingitis manifests itself in increased width of the tubal lumen due to enlargement, especially of the distal portion, of the tube, and in marked distortion of the tubal outline due to adhesions of the surrounding structures (Figs. 28 and 29). It is interesting, however, that contrary to all expectations, in one of our two cases illustrated here (Fig. 28), there was a patency of both tubes, while in the other case (Fig. 29), there was a patency of one and occlusion of the other tube.

The therapeutic effect of the lipiodol on inflammations was stressed by Cotte[27] in the acute cases and more recently by Greene and Pendergrass[72] and by Jarcho[103,104] in the chronic cases. We, too, have observed a complete relief of all symptoms in 12 cases of chronic inflammations of the adnexa following one or several injections of lipiodol.

Early pregnancy. As already mentioned the first attempts to demonstrate the presence of pregnancy by hysterosalpingography were made by Heuser.[84] At the International Radiological Congress in London, he[87] made the following emphatic

statement: "When a woman after conception, and after one or more missed periods, wants to know if she is pregnant, and the clinical examination is indecisive, lipiodol must be injected into the uterus. A radiograph should be taken in order to be absolutely certain." As regards the possibility of producing abortion by the injection of lipiodol (a foreign substance) into the gravid uterus, Heuser[87] says this: "In Buenos Aires, Dr. Uslenghi, Dr. Martinez and myself have tried to provoke abortion in tuberculous patients by this means when it was indicated, but we did not succeed." Very shortly after making these statements Heuser[86] reported the successful intrauterine injection of lipiodol in 48 cases of early pregnancy, without the slightest ill effect resulting either to the patient or to the offspring.

FIG. 28. Bilateral chronic salpingitis with dilatation and distortion of the distal portion of the tubes. Both tubes are patent.

FIG. 29. Bilateral chronic salpingitis with enlargement and distortion of both tubes. Patency of the left tube; occlusion of the right tube.

It is interesting, however, that in spite of this apparently very convincing work of Heuser, the majority of roentgenologists continued to remain reluctant to undertake the injection of gravid uteri, even in cases where therapeutic abortion was indicated, for fear that the probable dangers would be greater than the value of the information obtained by the procedure. This, notwithstanding the fact that those few who tried the method were practically unanimous in reporting that no untoward effects could be observed from the injection.

A careful review of the publications dealing with hysterosalpingography in early pregnancy reveals that Dyroff[46,47] Nuvoli,[141] Arnstam and Reinberg,[3] Steinharter and Brown,[200] Nahmmacher,[137,138] and others, believe that the method is of considerable value and its use therefore permissible. Nahmmacher,[135] in describing the successful use of hysterography in 7 cases of early pregnancy, mentions a case in which the fragment of a pessary applied by the patient for the production of artificial abortion was removed by the injection of iodipin and the pregnancy continued to full term. Bakke[7] successfully performed diagnostic hysterography in 17 cases of early pregnancy without any deleterious effects.

Le Goff[117] is of the opinion that the intrauterine injection of lipiodol, although a harmless method, does not always lead to a satisfactory diagnosis in pregnancies before the second or third month, therefore

its use as a routine prodedure is not advisable. Popovič[148] likewise believes that "pregnancy, regardless whether it continues normally, or has already led to abortion or to placentar remnants in the uterine cavity, always produces the same hysterographic picture" and that consequently the method is of value only in conjunction with other clinical signs. Rucker and Whitehead[174] think that hysterography, since it may lead to occasional abortion, should be reserved only for those doubtful cases of pregnancy which in case of positive findings may constitute indications for therapeutic abortion. Gauss[65] after carefully investigating the opinion of the different authors on the problem found that "the early diagnosis of uterine pregnancy is considered by many as an indication, but by thrice as many as a contra-indication" to hysterography.

It is very interesting in this respect to note a recent article of Miller and Martinez[126] who used diagnostic hysterography in 15 cases of early pregnancy, none of which gave signs of threatened abortion before the test. Although a positive diagnosis of pregnancy could be made in all instances, 3 of the cases aborted—three four and five days, respectively, after the injection. For this reason, the authors gave up entirely the diagnostic use of hysterography in pregnancy. This communication is very important since as Hickey[95] says: "It has put on record the possible danger of the employment of lipiodol in the diagnosis of pregnancy."

Fig. 30. Pregnancy, ninth week.

Fig. 31. Pregnancy, ninth week.

Heuser,[94] although aware of the above accidents, continues to advocate hysterography in early pregnancy, but he adds: "Of course, if the sound is introduced too deep and the injection is made with force, abortion is produced; however, this is a fault of technique and not of procedure."

In our series 7 cases of pregnancy were injected with lipiodol, all except one (Fig. 37) previous to the ninth week. The cases were selected very carefully and only those were chosen in which either a therapeutic abortion was contemplated, or where diagnosis was so uncertain that the ruling out of pregnancy previous to resorting to other procedures was imperative. In none of the injected cases were there any ill effects following the injection; 5 of the cases came to term, normal babies having been delivered, and in the other 2 subsequent therapeutic abortions were performed (after the injection of lipiodol failed to produce the abortion). In spite of these favorable re-

sults, however, we still feel that the employment of hysterography in pregnancy should be most carefully considered and the procedure used as a last resort only in well-selected cases.

FIG. 32. Pregnancy, eighth week.

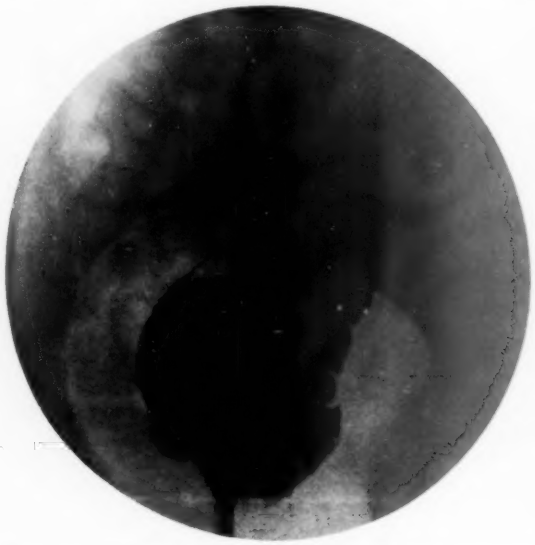

FIG. 33. Pregnancy, eighth week, oblique position.

The most characteristic sign of the injected pregnant uterus is a marked increase in size of the uterine cavity greatly in excess of that observed in any other condition, considering the size of the fundus (Figs. 30, 31, 32 and 33.) Each case required over 35 c.c. of oil or approximately ten times the amount required to fill the normal cavity. Of further interest is the fact that the triangular outline of the normal uterine cavity is lost in the early weeks of gestation and instead becomes more oblong or ovoid. The site of attachment of the ovum can be readily demonstrated by the characteristic filling defect evident on the roentgenogram. Of particular interest in this connection is the peculiar web-like distribution of the oil about the unattached portion of the ovum, a point which is of especial value in the differential diagnosis of myomas and early pregnancy

It has been suggested that hysterosalpingography may be of aid also in extrauterine pregnancy. Dyroff[46,48] described the "atony of the uterus without defect by unilateral tubal closure" as characteristic of pregnancy of the occluded tube. Schneider and Eisler [182,183] who made a very detailed investigation of the subject, on the basis of 10 cases of their own established the following criteria as more or less important: (1) Extrauterine pregnancy can be safely excluded if both tubes are patent; (2) atony of the uterus without a filling defect due to intrauterine implantation of the ovum constitutes indirect evidence of extrauterine pregnancy, and (3) the occluded tube may show a variation of forms of filling defects, the most typical among them being the "segmentation" and "the convex (club-shaped) contour of the proximal margin and the concave (trumpet-shaped) contour of the distal margin of the defect." Viallet and Jahier,[211] Jaroschka,[106] Gabastou and Harguindeguy,[64] and others, reported individual cases of extrauterine pregnancy in which the intrauterine injection of lipiodol proved a considerable help in establishing a correct diagnosis. More recently, Popovič and Smokvina,[149] on the basis of 23 cases injected (of which only 5 were verified at operation), found that extrauterine pregnancy gives, in the majority of instances, a rather typical picture following

hysterosalpingography. These latter authors also insist, in conjunction with the filling of the uterine cavity, on a sign which they call "the ruptured bladder appearance." According to Popović[148] this sign, which may occur in both intra- and extrauterine pregnancy is the result of the lipiodol penetrating into the sinuses of the uterine blood vessels, while Schneider,[180] who also observed the phenomenon in extrauterine pregnancy (and assumed that it may occur in all types of pregnancies) thinks that it is due to the distribution of the lipiodol within the loose uterine decidua. It is, however, admitted in both instances that the primary cause leading to this peculiar arrangement of the injected lipiodol is to be sought in the atony of the uterus, which thus constitutes an indirect evidence of pregnancy.

Other investigators believe that hysterosalpingography is of a questionable value in extrauterine pregnancy and that errors in diagnosis are possible. Schneider and Eisler[182] themselves report a case which they diagnosed as an extrauterine pregnancy and which at operation proved to be a pus tube complicated by a recent abortion. Rucker and Whitehead[175] describe a similar case, in which "hysterosalpingograms showed an atonic uterine shadow and a closed, clubbed left tube. At operation a tubo-ovarian abscess was found, which most likely was a postabortal one." Very interesting is a case of Jungmann[111] where there was no atony of the uterus, the cavity appeared of normal size and shape, and both tubes were patent, and where a diagnosis of extrauterine pregnancy could still be made from the fact that there was an enormous dilatation of the distal portion of one tube and a peculiar distribution of the lipiodol (this having penetrated between the mucous membrane of the tube and the decidua capsularis).

Nahmmacher,[138] Haselhorst,[80] and others, likewise believe that hysterosalpingography is of questionable value in the diagnosis of extrauterine pregnancy and they advise against the method.

Uterine Tumors. The injection of lipiodol in connection with the diagnosis of uterine tumors is of value only in those instances in which the cavity of the uterus is enlarged, distorted or encroached upon. Apart from pregnancy, the diagnostic importance of which has already been discussed, fibroids and cancer are the predominating tumors which lead to changes in size and form of the uterine cavity.

For this reason they, and more especially the fibroids, have formed a favorite topic of investigation from the earliest days of hysterosalpingography. Indeed, Ferré,[50] in 1925, published a comprehensive study on the diagnostic value of lipiodol in 6 cases of uterine fibroma. Later, Joachimovits,[107] Henkel,[83] Nahammacher[133,134,138] Mocquot and Bureau,[132] and Grégoire, Béclère and Darbois,[78] made further contributions to the subject, the latter insisting on the special value of outlining the contour of the tumor by a lead wire during the taking of the roentgenogram. Samuel,[178] Jung,[109] Vidakovitch and Smokvina[212] published additional cases in support of the view, expressed previously by Henkel and Nahmmacher, that hysterosalpingography permits the exact localization of small submucous or intramural fibromas, thus making a conservative excision of the tumor possible.

More recently, Castronovo,[23] Béclère, Darbois and Ledoux-Lebard[15] and Mathieu[123] presented some very convincing material, especially as regards the differential diagnosis of large uterine fibromas from adnexal or ovarian tumors.

Investigations on the applicability of lipiodol injection for the diagnosis of cancer were made by Carreras, Figueras and Faixat[21] who described a case of suspected uterine malignancy where subsequent hysterosalpingography revealed a uterus didelphys. Likewise, Mocquot,[131] Proust

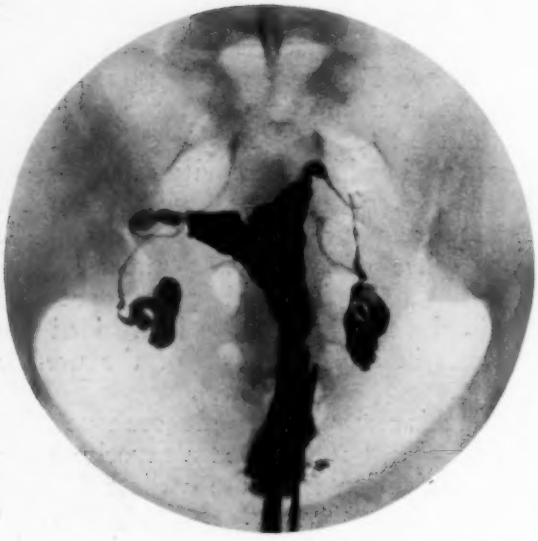

FIG. 34. Diffuse polypoid endometrium. Both tubes are patent.

FIG. 35. Small submucous fibroid with limited distortion of the uterine cavity. Bilateral tubal occlusion.

and Béclère[151] and Michon[124] reported several cases in which the use of lipiodol injection aided in proving or disproving the diagnosis of uterine carcinoma. Mocquot was of the opinion that lipiodol often makes a diagnostic curettage in carcinoma of the body of the uterus unnecessary. Other investigators, however, considered the presence of a malignancy as a contraindication for hysterosalpingography for fear that the injected oil may carry some of the tumor cells into the abdominal cavity thus helping to spread the disease.

In our own series, we have made no attempt to inject the uterus or adnexa of any patient suspected of having a malig-

FIG. 36. Submucous fibroid with marked increase in the size of the uterine cavity and filling defect.

FIG. 37. Pregnancy complicated with uterine fibroid, twelfth week.

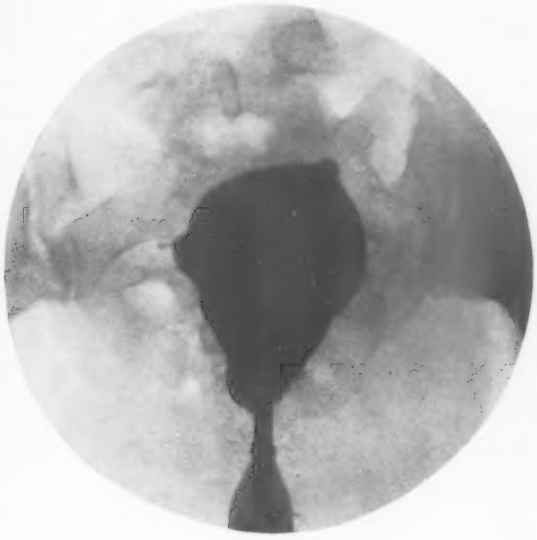

Fig. 38. Uterine fibroid, with marked enlargement of the uterine cavity.

Fig. 39. Uterine fibroid with marked enlargement and distortion of the uterine cavity.

nant lesion, but have confined our studies entirely to the group of fibroids. Even here, owing to the fact that the majority of these tumors can be readily demonstrated by pelvic examination, only those cases were selected in which diagnosis was uncertain or impossible. This applies especially to certain cases of polyposis (Fig. 34), the very small submucous and intramural fibroids which, on account of their size and position, could not be palpated (Figs. 35 and 36) and to the fibroids complicated with pregnancy (Fig. 37), or in which a differential diagnosis from pregnancy was necessary.

In considering distortion of the uterine cavity resulting from the development of fibroid tumors, it must be emphasized that any type of distortion may be expected, depending somewhat upon the size, number and location of the tumors present in the uterus (Fig. 38, 39, 40, 41, 42, and 43). We have observed many types of distortion varying from a small filling defect in the fundus (Figs. 29 and 30), to an irregularly shaped cavity, the outline of which when injected produces a shadow as large as a grapefruit (Figs. 37 and 45). In several of our cases so great an enlargement of the uterine cavity was observed, that 50 to 75 c.c. of lipiodol was required to fill the cavity (Figs. 42 and 43). This is merely of academic interest and is of no value as regards the pathology within the fibroid, that is, it does not indicate a tendency to degeneration, either malignant or otherwise.

In subserous fibroids, due to the fact that very little distortion of the uterine cavity is produced, and owing to the ease with which such tumors are recognized at bimanual examination, the use of hysterosalpingography is of little benefit.

Extrauterine Tumors. The value of hysterosalpingography as an aid in the diagnosis of extrauterine tumors has, up to the present time, been limited to the more common types of such tumors, viz., the large ovarian cysts and cysts of the broad ligaments, which could be palpated but not always differentiated from uterine or other pelvic tumor masses. The findings in these cases vary in proportion to the size and position of the tumor. When there is little or no distortion of the tube, and its lumen is patent, the lipiodol after entering the pelvis may distribute itself around the

FIG. 40. Large uterine fibroid with crescent-shaped distortion and marked enlargement of the uterine cavity.

FIG. 41. Multiple submucous and intramural fibroids with irregular enlargement and distortion of the uterine cavity.

FIG. 42. Large uterine fibroid with enormous enlargement of the uterine cavity and endometrial implant, lateral view.

FIG. 43. Large intramural fibroid with enlargement and distortion of the uterine cavity.

Fig. 44. Ovarian cyst. Normal uterine cavity. Distribution of the oil around the tumor.

Fig. 45. Large uterine fibroid producing enormous enlargement of the uterine cavity which, due to the defect produced by the protrusion of the fibroid, somewhat resembles the distribution of the oil as in Figure 44.

border of the cyst so that its outline can be demonstrated on the roentgenogram (Fig. 44).

In the case of intraligamentous and ovarian cysts of large size, an elongation and enlargement of the fallopian tube on the affected side due to the distention produced by the tumor is occasionally observed. Ronvé,[161] Henkel[83] and Nahmmacher[138] described this phenomenon as a most important sign, while others, as for example Temesváry,[204] denied its significance. Rosenblatt and Kass[163] insist also on the not infrequent distribution of the lipiodol on the surface of part of the tumor.

We have repeatedly observed the entrance of the contrast lipiodol into the immensely enlarged and dilated tube often producing a bizarre semicircular shadow extending high up toward the abdomen (Figs. 46 and 47). As would be expected, no distortion of the uterine cavity is produced in these cases unless the cyst is of such a size as to encroach upon the body of the uterus and then distortion is only evident when the uterus is elongated or displaced as a result of the development of the cyst.

The most important practical value of hysterosalpingography in connection with extrauterine tumors is in the differentiation between these and large uterine fibromas, when an accurate diagnosis cannot be made by the usual methods of gynecologic examinations. It is advisable in such instances to outline the margins of the tumor by a lead wire placed on the abdominal wall during the taking of the roentgenogram and then to analyze the relation of the uterine cavity to the lead wire. If the uterine cavity appears of normal size and shape, but on the periphery of the lead wire, the condition is that of a cyst (Fig. 49), while if the uterine cavity is enlarged, distorted and appears in the center or near the center of

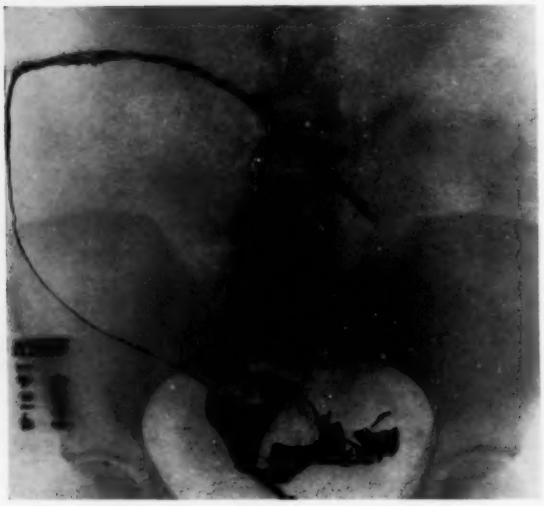

FIG. 46. Large ovarian cyst. Normal appearance of the uterine cavity with elongation of the right tube.

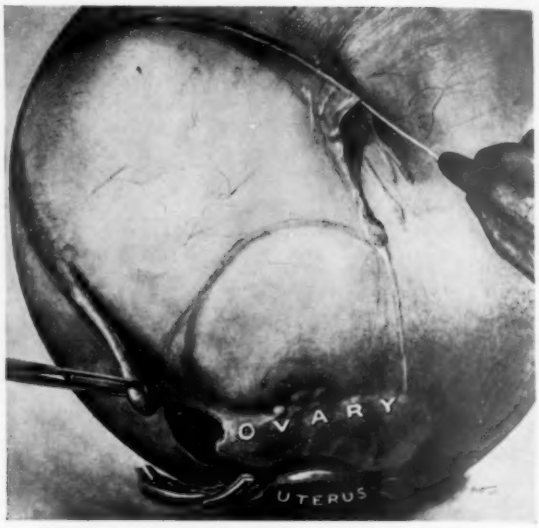

FIG. 47. The specimen of Figure 46 showing the relation of the elongated tube to the ovarian cyst.

the lead wire, the condition is that of a uterine fibroma (Fig. 48). The addition of roentgenograms in the lateral view will occasionally aid in further substantiating the diagnosis.

SUMMARY

Hysterosalpingography by means of lipiodol is a safe and simple procedure. In a series of 512 personal cases, the only accident observed was that of a ruptured tube, which led to no ill effects.

The method is of great diagnostic value in developmental anomalies of the genital organs, in tubal affections leading to

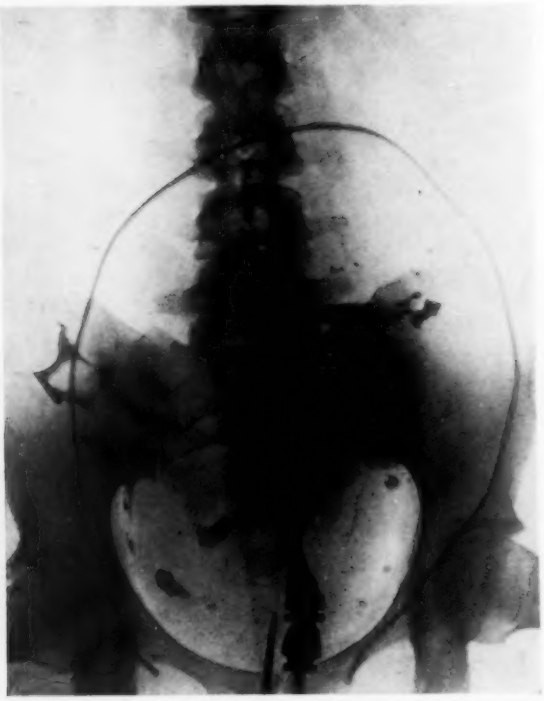

FIG. 48. Large uterine fibroid. The contour of the tumor is encircled by lead wire. The uterine cavity is centrally placed but enlarged and distorted.

FIG. 49. Large ovarian cyst. The contour of the tumor is encircled by lead wire (Fig. 48). The uterine cavity is normal but is displaced by tumor.

sterility, in certain very carefully selected cases of pregnancy in which therapeutic abortion is indicated or where a differential diagnosis from other obscure conditions is essential, in uterine tumors, excepting malignancies, and in certain extrauterine tumors.

The contraindications are recent hemorrhage, inflammatory conditions that are not completely quiescent, active infections or malignancies involving the cervix, previous intrauterine interventions, ectopic gestations or uterine gestation in which a therapeutic abortion is not desired, infected cervical or uterine polyps and fever.

In certain instances the injection of lipiodol is of direct therapeutic value.

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ROENTGEN DIAGNOSIS OF LESIONS OF THE JEJUNUM AND ILEUM*

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LESIONS of the jejunum and ileum are uncommon, the literature on this subject is meager, and discussions in the standard textbooks lack completeness and detail. Clinical diagnosis is very difficult except in certain cases of obstruction. Not infrequently the roentgen examination is of great aid in arriving at a diagnosis, and helps in determining both the pathological process present and its location. It has seemed worth while, therefore, to summarize the conditions in which roentgenologic studies may be of value and review the roentgen findings in the various lesions.

FIG. 1. Normal small bowel. Four hour plate. The jejunum is mottled and snowflaky. The ileum is smooth and sausage-like.

The roentgen examination is usually carried out after the ingestion of a barium sulphate meal. Films and roentgenoscopic observations are made at varying intervals according to the circumstances of the individual case in order to study the progress of the meal through the alimentary canal. Normally, the opaque mixture begins to pass out of the stomach almost immediately after ingestion and the small bowel commences to fill within a few minutes. The jejunum presents a snowflaky, feathery outline due to the valvulae conniventes or folds of Kerkring in the mucous membrane; it lies in the left upper and midportions of the abdomen. The ileum is smooth and sausage-like in appearance and occupies the lower portion of the abdomen and pelvis. The loops of jejunum are about an inch and a half in diameter, are separated from one another by a short distance, and tend to run obliquely and vertically. The ileum is somewhat narrower than the jejunum, the loops lie very close together, and run more transversely (see Fig. 1). The transition from jejunum to ileum is gradual, so that it is practically impossible to determine where one ends and the other begins. The upper two-fifths of the small bowel from the duodeno-jejunal junction is considered jejunum and in the average individual is about 9 feet long; the remaining three-fifths, usually about 13 feet in length, is ileum.

The lesions of the small intestine which may be demonstrated by roentgen examination and in which this type of study is of assistance may be classified as follows:

1. Obstruction, which may be partial or complete
2. Hypermotility
3. Diverticula

* From the X-ray Department of the Boston City Hospital.

4. Malpositions and displacements
5. Adhesions
6. Tuberculosis
7. Ulcers
8. Neoplasms
9. Foreign bodies
10. Postoperative changes.

1. *Obstruction.* The roentgen examination is of great value in the diagnosis of intestinal obstruction. By its aid, it is possible to determine the degree of obstruction, and also in many instances to localize the site of the lesion. There are two methods of study in this type of case: (*a*) by plain films of the abdomen; (*b*) by studies after the administration of an opaque meal.

(*a*) The plain film method is applicable in cases in which the obstruction is accompanied by the presence of gas in the small bowel. Gas in the small intestines is always of pathological significance and indicates obstruction (see Fig. 2). Case [3] has called attention to two types of small bowel outline which may be demonstrable: (1) a herring bone appearance due to the gas causing the folds of Kerkring to stand out by contrast, and (2) a ladder arrangement of the shadows of the small bowel when the distended loops lie parallel. The latter appearance he believes pathognomonic of a degree of acute obstruction requiring immediate operation. The former aspect indicates an obstruction of serious significance also, but has been seen to appear and later disappear spontaneously. Conservative treatment is indicated when the herring bone type of small bowel is demonstrated. The general location of the obstruction may be determined if there is fluid as well as gas in the intestines. If one or more loops of small bowel show gas and fluid, it may be inferred that the obstruction is distal to this point. The exact site of the pathological process may not be demonstrable but great assistance can be given the surgeon by indicating in which region the best surgical approach to the lesion may be made. The roentgen examination gives most information if made with the patient standing or sitting, as it is in these positions that the fluid levels with gas above are most easily demonstrated. With very sick patients, plates made in the lateral positions may suffice.

The diagnosis of obstruction by the plain film method has the great advantages of simplicity and speed. If the patient is too ill to be taken to the roentgen-ray room, a satisfactory examination is possible with the bedside machine. This is particularly important in postoperative cases with ileus or possible obstruction, as the patient need not be moved from his bed, it being necessary merely to slip a film under the back and make the roentgen exposure. The diagnosis can be made within a few moments from the wet films or by roentgenoscopic studies, while the barium meal method may require twenty-four hours or more to determine the presence of obstruction. Another important advantage of the plain film method is that it does not fill the small bowel with barium sulphate, which may greatly increase the difficulties of operation if im-

Fig. 2. Intestinal obstruction. The small bowel is markedly distended with gas.

FIG. 3. Intestinal obstruction. Films made twenty-four hours after ingestion of an opaque meal. The small bowel is distended. The point of obstruction is in the right lower quadrant. Operation disclosed a strangulated internal hernia with complete obstruction.

mediate surgery is necessary. This is particularly true if the patient is dehydrated, in which case the fluid portions of the opaque meal are absorbed, leaving the barium sulphate behind as a firm mass. The objection to the plain film method is that it is not positive in all cases of obstruction and gives much less accurate indication of the site of the lesion and degree of obstruction than the barium meal method. However, since the clinician is usually more concerned as to whether there is obstruction than as to its exact location and as early diagnosis may be of extreme importance to the welfare of the patient, the plain film method should always be tried first in every case of suspected obstruction.

(*b*) In order to understand the opaque-meal method of diagnosing obstruction, it is necessary to keep in mind the physiology of the alimentary canal. Normally, movement of food through the small bowel takes place principally in three ways: by rhythmic segmentation, pendulum movement, and peristaltic rush. The rate of progress varies widely within normal limits. Ordinarily, the opaque meal begins to pass out of the stomach almost immediately after ingestion and in about four hours the head of the column has reached the cecum. It usually requires about twelve hours for the small bowel to empty itself completely. Retention of the barium in the small bowel at eighteen hours is significant; the finding of barium in the loops of ileum or jejunum twenty-four hours or more after the meal is taken is definitely pathological (see Fig. 3). If there is dilatation of the loops associated with the retention, a definite diagnosis of obstruction is possible.

With complete obstruction, the roentgen examination after the administration of an opaque meal gives very definite and easily recognized findings. The barium mixture is seen proximal to the point of obstruction,

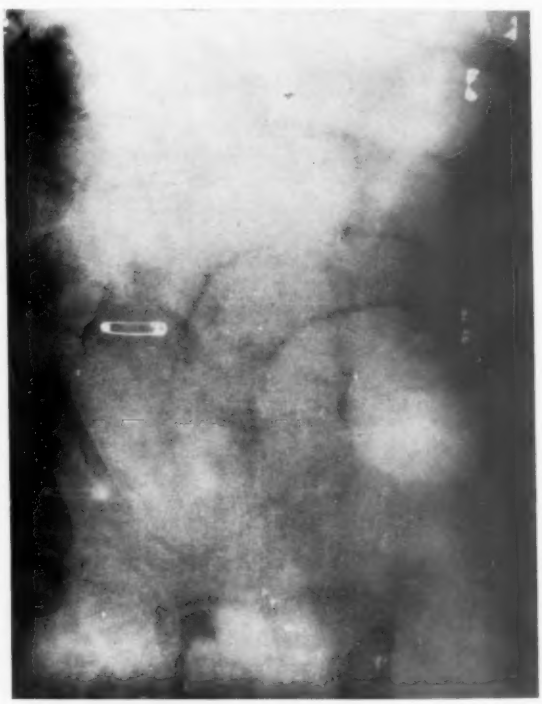

FIG. 4. Intestinal obstruction. Marked distention of small bowel. The opaque mixture is diluted and casts a faint shadow because of the large amounts of fluid in the small bowel. Twenty-four hour film.

with none or very little distally. The small bowel is distended and by the character of the loops involved an idea as to the site and possibly also the etiology of the lesion may be obtained. Repeated examinations at intervals show marked retention. If there is fluid in considerable quantities in the intestines, the barium is diluted and casts a much fainter shadow than normally; the loops are very large, are parallel to and close upon one another, and lie transversely in the abdomen (see Fig. 4). If the patient is dehydrated, the fluid is absorbed and the barium stands out very prominently as a dense white shadow.

It must be stressed that not every case showing retention of barium in the small bowel at twenty-four hours should be diagnosed as obstruction. Factors outside the small intestines may cause wide variations in motility. Delay in the emptying of the stomach as in pyloric or duodenal obstruction will cause apparent retention in the jejunum and ileum. Obstructive lesions in the proximal portions of the colon may have similar effects (see Fig. 5). In rare instances, regurgitation from the cecum may be mistaken for stasis in the ileum. In none of the above-mentioned instances will there be dilatation of the small bowel associated with the stasis.

2. *Hypermotility*. As stated above, the time normally required for the passage of a barium sulphate meal through the small bowel is eight to twelve hours. Emptying in less than six hours is considered increased motility. In the routine roentgen examination of the gastrointestinal tract, most roentgenologists make observations at the time of ingestion of the opaque meal and again at six and twenty-four hours. The proximal loops of jejunum are seen at the first examination and the terminal ileum is usually visualized at six hours. If there appears to be increased motility in the jejunum or if the entire small bowel is empty at the six hour test, special studies should be carried out to determine the motility of the small intestines.

FIG. 5. Apparent stasis in ileum. Twenty-four hour plate. Obstruction at splenic flexure due to carcinoma causing stasis in the terminal ileum.

Observations, which should include both films and roentgenoscopic studies, should be made at hourly or half-hourly intervals after the ingestion of the opaque meal. In this way, it is possible to establish the exact emptying time and determine the degree of hypermotility. It may enable the observer to state whether there is a local lesion present such as an ulcer or a tuberculous process, whether the increased motility is confined to one portion of the tract, or whether it is part of a general process. The emptying time of the stomach should also be noted. If the stomach empties too rapidly, as in achylia, certain forms of carcinoma, or after gastroenterostomy with poor functioning of the stoma, there may be resultant apparent hypermotility in the small bowel. Purgative drugs may also cause hurrying of the meal through the small bowel. By repeated examinations at intervals of several weeks, the progress of the case and the efficacy of therapeutic

Fig. 6. Diverticulum. Large solitary diverticulum proved at operation.

measures may be demonstrated in a graphic and quantitive manner.

3. *Diverticula.* Diverticulum of the small bowel occurs in two forms: (*a*) the single pouch, and (*b*) the multiple type. The solitary pouch may be present in any portion of the small intestine and varies in size from a dime to as large as a plum (see Fig. 6). They may be congenital, as for example Meckel's diverticulum, or acquired. The multiple type are usually part of a generalized diverticulosis involving both the large and small intestines. The diverticula vary in size from a pea to a five-cent piece and there may be but a few or very many present.

The diagnosis is difficult as the pouches may be overshadowed by the opaque mixture in the intestines. Careful roentgenoscopic studies to separate the coils of the small bowel and examination with the patient standing are essential. If there is stasis in the pouches, rounded areas of density remain distributed along the course of the small bowel after the main mass of barium has passed along. The degree of retention in the diverticula should be determined by examinations at intervals of twelve or twenty-four hours until there is complete emptying, as stagnation increases the possibility of infection. Fixation or diminished mobility and localized tenderness over the region of the pouches on roentgenoscopic palpation is significant of the presence of inflammatory changes within and around the diverticula, causing a diverticulitis.

4. *Malpositions and Displacements.* Pressure defects and displacements of the small bowel are relatively common, give very important diagnostic information, and are easily demonstrable. The examination is best carried out by roentgen films and roentgenoscopic observation made at inter-

Fig. 7. Pregnant uterus displacing small bowel. Three hour film showing typical upward displacement of small intestines. Re-examination one month later showed the fetal skeletal outline and increase in the size of the uterus.

vals of one-half to two hours after the ingestion of a barium sulphate meal. The times at which the observations are made vary with each individual case and the study should be continued until the intestines are empty. Tumors of the pancreas usually displace the jejunum downward; those of the spleen toward the mid-line. Renal tumors cause a downward and outward displacement. Mesenteric masses may be demonstrated by the fact that no small bowel loops are visible in portions of the abdomen where they normally should be seen.

Pelvic tumors are particularly easy to show, and the location, size, and probable nature of the mass can be determined. The ileum normally descends into the pelvis; the loops extend well out to the left and right of the mid-line and are distributed uniformly. Enlargement of the uterus during pregnancy displaces the small bowel upward and outward. (see Fig. 7). In this way, the probability of early pregnancy may be determined two or three months before the fetal skeletal outline is visible. Cysts, fibroids, and other pelvic tumors may, if sufficiently large, be outlined in this way also. These latter masses are usually not in the mid-line, so that the resultant displacement of the ileum is more or less to one side (see Fig. 8). Uterine enlargements are as a rule in the mid-line and extend symmetrically to each side. The differential diagnosis between the pregnant uterus and other pelvic tumors may in many cases be definitely established by re-examination after an interval of one or two months. The uterus enlarges in an orderly, easily demonstrable manner from month to month. Cysts, fibroids, etc., may also change in size during this time, but the growth will in all probability not correspond in size, shape, and position to that seen in the pregnant uterus. A full or distended bladder may also displace the small bowel upward out of the pelvis. A second examination after emptying the bladder will show that the bowel has returned to its normal position if the displacement has been due entirely to the presence of the full bladder.

Fig. 8. Displacement of small bowel by a pelvic tumor. Large ovarian cyst on left. Film made at three hours.

A typical displacement of the terminal ileum is seen in the presence of low-grade appendix abscess. This has been described by the author in detail elsewhere.[4] The loops of small bowel tend to encircle the abscess in an attempt to wall it off, giving a picture which should permit of a clinical diagnosis preoperatively. A pelvic abscess may give similar findings. In this case, the mass is usually lower down and involves loops of ileum other than those lying directly proximal to the cecum.

Large hernias may contain a portion of the small bowel. The danger of strangulation can be demonstrated on the roentgenogram in a striking manner by the presence of loops of intestine lying outside the abdominal cavity. In a case of a very large

Fig. 9. Large scrotal hernia. Six hour film. The ileum extends down almost to the level of the knees.

scrotal hernia (see Fig. 9) the loops of ileum were seen extending out of the abdomen almost to the level of the knees. In showing ventral or inguinal hernias lateral views are essential. Examination with the patient erect is also important. A diaphragmatic hernia may permit the loops of small bowel to pass into the thorax. There is usually a history of severe trauma or of a gunshot or stab wound. The roentgen examination gives typical and easily recognizable findings, though the diagnosis may be very obscure if this examination is omitted. In eventration, the diaphragm rises to a much higher level than normally and the small bowel may be displaced upward. Ascites causes an elevation and separation of the loops of small bowel, as though the intestines were afloat in the fluid. The picture is typical (see Fig. 10). In ptosis of the small bowel, usually associated with generalized ptosis, the jejunum and ileum may be very low and lie entirely in the pelvis (see Fig. 11).

5. *Adhesions.* Adhesions may cause fixation, abnormalities of position, and changes in the size and contour of the small bowel. Fixation or limited mobility of the loops of intestines is best shown by roentgenoscopic studies. Observations with the patient erect and in the oblique and lateral positions are essential. Abnormalities of position and contour include kinking, narrowing of the lumen, dilatations and displacements. Delay or obstruction should be ruled out by frequent observations, which must be repeated until the small bowel is completely empty.

6. *Tuberculosis.* The subject of tuberculosis of the intestines has been covered in great detail by various authors and a large literature has accumulated on this subject. Brown and Sampson[1] have recently published a very complete discussion and résumé of this entire subject in book form. They describe the findings

Fig. 10. Ascites. The loops of small bowel are high and separated from one another and appear afloat in the fluid.

and technique in detail and the reader is referred to their book, as space does not permit of an adequate discussion of this subject. Irritability with hypermotility and filling defects are the most common findings. These changes are usually associated with characteristic lesions in the cecum and ascending colon, which are of great assistance in arriving at a diagnosis (see Fig. 12).

Tuberculous peritonitis may occasionally be diagnosed by roentgen studies of the small bowel. The examination reveals diffuse adhesions and multiple, irregularly scattered narrowings of the small bowel. The intestinal loops tend to run in irregular bizarre patterns and are shorter and narrower than usual (see Fig. 13). Roentgenoscopy reveals extensive adhesions. If fluid is present in the abdominal cavity, the changes seen with ascites may be demonstrable as described above.

Fig. 11. Ptosis. Very low position of the gastrointestinal tract.

Fig. 12. Tuberculosis of the terminal ileum and cecum. Filling defects, irregularity and irritability. Six hour film.

7. *Ulcers.* Ulcers of the small intestines are very difficult to diagnose. There is narrowing of the lumen and in the case of the jejunum the normal folds are markedly diminished or entirely absent in the region about the lesion. An ulcer niche or crater may be present within this area. The demonstration of a niche makes the diagnosis certain. This defect is best seen with the patient standing. It may be possible, also, to bring it into view by pressure with the hand or with an inflated rubber bladder pressed firmly against the abdomen. Careful palpation under roentgenoscopic control is essential to separate the loops of small bowel. Otherwise, the lesion may be covered and the diagnosis missed. Spasticity of the small bowel and localized tenderness are important indirect signs, though tenderness is present in so many other conditions that it is of help only in a general way.

Fig. 13. Tuberculous peritonitis. The small bowel is markedly narrowed, irregular and fixed.

Jejunal ulcer is most commonly seen after gastroenterostomy, is very rare in females, and may occur in two weeks to six months after the operation. It also occurs after subtotal gastrectomy if free hydrochloric acid persists. If the lesion is close to the site of the anastomosis, there will be narrowing and deformity of the stoma. The opening may be closed partially or entirely, with gastric retention, dilatation of the stomach, and probably hyperperistalsis. Camp[2] states that gastrocolic fistula in the absence of malignancy always indicates gastrojejunal ulcer. We have seen one fistula of this type produced surgically during an attempted gastroenterostomy for peptic ulcer.

8. *Neoplasms.* Both benign and malignant tumors of the small bowel are known to occur. However, these neoplasms are extremely rare and only occasionally do they present typical roentgenologic or clinical findings. There may be a localized narrowing of the lumen or obstruction, which gives a clue to the diagnosis. As a rule, the roentgen examination fails to prove the presence of a tumor and only at operation is the true nature of the pathology discovered.

9. *Foreign Bodies.* Many types of foreign bodies may be present in the small bowel and those that are sufficiently dense to be opaque to the roentgen rays are easily demonstrable. Gallstones, enteroliths, and various substances which have been swallowed are the objects most commonly found. The passage of the body should be followed by repeated examinations. This is particularly important in the case of objects with sharp edges, substances which appear too large to pass through the ileocecal valve, or open safety pins. In rare instances, an opaque meal may be of assistance in proving the presence of a nonopaque foreign body or to show definitely that an object whose location is in doubt actually is in the small bowel.

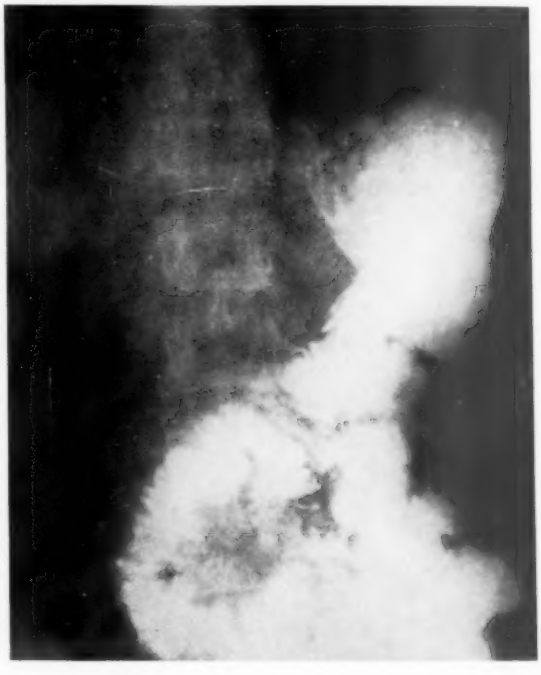

Fig. 14. Gastroenterostomy. Film fifteen minutes after ingestion of opaque meal. Very rapid emptying. Stomach entirely empty in one hour.

10. *Postoperative Changes.* The study of the small bowel after operation is both interesting and valuable. After gastroenterostomy, roentgen studies should be made to check the site and functioning of the stoma. It is our custom to observe every gastroenterostomy case within two weeks after operation, again at three months, and then at six months to yearly intervals thereafter. Poor function may show itself as delay in emptying or more frequently in too rapid emptying. In many instances, we have demonstrated that the stoma allows the entire meal to pour out of the stomach with great rapidity (see Fig. 14). The small bowel undergoes marked dilatation and the food passes along to the colon much more rapidly than normally. Jejunal ulcer after gastroenterostomy may be demonstrated as previously described and the presence of a vicious circle may also be determined by roentgen examination. Postoperative adhesions may cause narrowing of the lumen, fixation, and displacement of the loops of small bowel. After ileocolostomy, roentgen studies by the opaque meal and barium enema methods are very important to check the site and functioning of the anastomosis. In cases of colectomy, the small bowel distends and may take on both the form and function of the colon to a certain extent.

SUMMARY

A brief résumé has been given of the conditions affecting the jejunum and ileum which may be demonstrated by the roentgen examination and in the diagnosis of which this method of study is of value. These lesions are rare, but of great importance. Diagnosis is as a rule difficult or impossible by the usual clinical methods, and roentgenologic studies are frequently the only means of arriving at a diagnosis preoperatively. The literature on this subject is meager and the discussions in the texts are usually brief and not comprehensive.

The conditions discussed are: (1) obstruction; (2) hypermotility; (3) diverticula; (4) malpositions and displacements; (5) adhesions; (6) tuberculosis; (7) ulcer; (8) neoplasms; (9) foreign bodies, and (10) postoperative changes. The roentgen findings of each of these conditions are discussed briefly and the chief diagnostic points outlined.

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A ROENTGEN-RAY GENERATING SYSTEM IN WHICH THE SIZE OF THE FOCAL SPOT IS AUTOMATICALLY ADJUSTED TO THE LOAD*

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IN ROENTGENOGRAPHY the two factors, speed and definition, are opposed to one another, so that in general one is obtained at the expense of the other. Where high speed is required a tube with a relatively large focal spot is used, with consequent loss of definition, and where fine definition is required a tube with a smaller focal spot is employed, with consequent loss of speed.

The use of fixed focus tubes with different sizes of focal spot for different purposes entails a certain loss of time in changing from one tube to another and a certain loss of tubes through breakage in handling. It is also, at best, a compromise and will in general be far removed from the ideal condition in which the size of focal spot would always be as small as could safely be used for the load in question.

ADJUSTABLE FOCAL SPOT

The size of the focal spot can readily be adjusted in a hot-cathode tube by a method suggested by Dr. Irving Langmuir. The result is obtained by varying the potential of the focusing member of the cathode with respect to the electron emitting portion. Figure 1 shows a schematic diagram of the cathode of such a tube, and Figure 2 shows an experimental model of such a cathode.

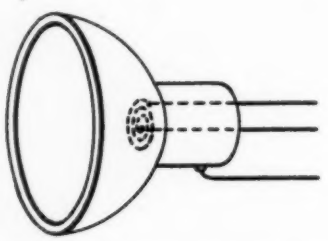

FIG. 1. Schematic diagram of cathode for variable focus roentgen-ray tube.

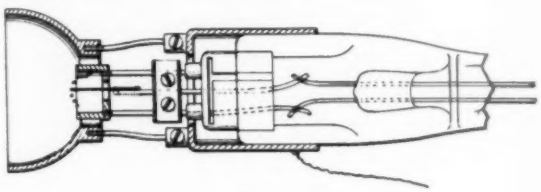

FIG. 2.

In such cathodes another lead is brought out in addition to the usual filament leads. It is through this extra lead that the negative biasing potential is applied to the focusing member to cause the cathode stream to converge more or less sharply on the anode as more or less negative potential is applied.

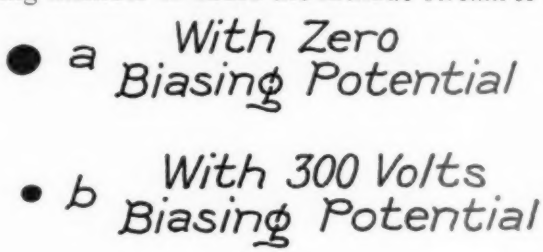

FIG. 3.

Figure 3 shows the pinhole camera focal spot pictures obtained, *a* with the focusing member at the same potential as the filament and *b* with the focusing member 300 volts negative with respect to the filament. Intermediate sizes of focal spot could be obtained with intermediate voltages.

The only objection to the use of such an adjustable focus tube in this simple

* Presented at the Thirtieth Annual Meeting, American Roentgen Ray Society, New York City, Sept. 17–20, 1929.

manner lies in the fact that it complicates matters for the operator who would be forced to remember constantly that every different size of focal spot has its own maximum allowable energy input. This

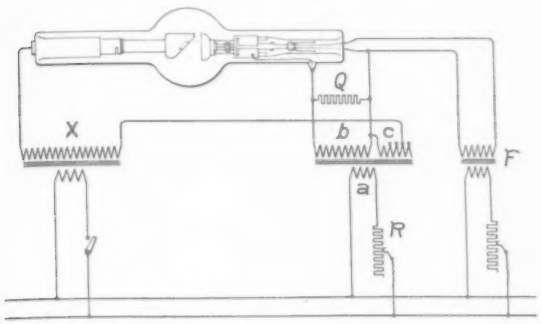

FIG. 4.
X = High tension transformer
F = Filament transformer
a, *b*, *c* = Biasing transformer
Q = Surge arrester

objection would disappear if, in some way, the focal spot could be adjusted *automatically* to the load.

AUTOMATIC ADJUSTMENT OF FOCAL SPOT[1]

One method of automatically adjusting the focal spot to the load is shown in Figure 4, in which *a*, *b*, *c*, is a transformer, the primary of which receives current from the supply lines through a resistance *R*. Coil *b* supplies a high negative potential to the focusing member on those half waves during which current flows through the roentgen-ray tube. (On the other half waves coil *b* would supply a positive charge to the focusing member but this would have no effect on the operation of the tube as there would be no current passing through it at that time.) The milliamperage which passes through the roentgen-ray tube also passes through coil *c* which is so connected that it increases the load on the primary *a*. This increased load reduces the voltage at the primary terminals due to the presence in the circuit of resistance *R*. The focusing potential from coil *b* is therefore reduced in proportion to the increase in milliamperage, and the focal spot size increased accordingly.

This method, in the simple form shown, is suitable for half-wave rectification.

Another method, and one suitable for either half- or full-wave generating systems, makes use of a small hot-cathode tube in the circuit used to supply the focusing potential. This tube, shown at *D* in Figure 5 acts as a resistance in the high tension circuit, causing the focusing member to assume a negative potential with respect to the filament. To secure proper control of the focal spot size it is necessary that the resistance of tube *D* should vary inversely with the load, and this condition is secured by lighting the filament from the same transformer which feeds the filament of the roentgen-ray tube. To increase milliamperage the stabilizer, or other filament control, is adjusted to allow more filament current to flow to the roentgen-ray tube. This automatically increases the filament current to tube *D* thereby lowering its resist-

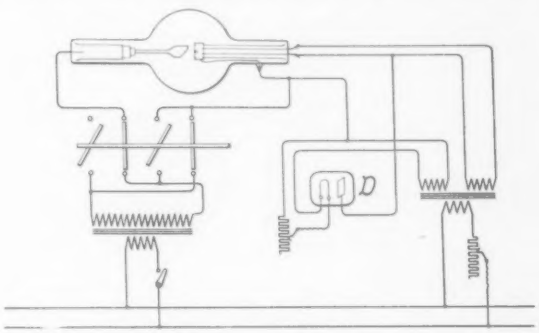

FIG. 5.

ance which in turn lowers the potential of the focusing member with respect to the filament. This results in a larger focal spot to carry the increased milliamperage.

Pinhole camera pictures of the focal spot of an experimental tube supplied

[1] Since this paper was presented the attention of the author has been called to an article by H. Franke, *Brit. J. Radiol.*, 1927, *23*, 134–139, containing a description of a tube in which automatic focusing is secured by controlling the potential of an internal focusing member.

from the generating system just described, are shown in Figure 6, in which the size of the smallest dot represents the

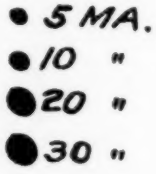

FIG. 6.

focal spot when the filament control is set for 5 ma., the next larger for 10 ma., and the two following for 20 and 30 ma., respectively.

For medical roentgenography, it will probably be desirable to increase the attainable range of focal spot sizes over that shown, and this can readily be accomplished by employing a cathode design which in the unbiased condition will give a larger focal spot.

The use of such a system as that described would seem desirable wherever one tube is called upon to cover a wide range of milliamperage. This would be true where roentgenoscopy is combined with rapid roentgenography. It would be especially true in the case of high power oil-immersed sets where the one tube must do all of the work.

Vol. XXIII, No. 2

CALCULATIONS OF TISSUE DOSAGE IN RADIATION THERAPY

A PRELIMINARY REPORT*

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THE last few years have witnessed several important advances in radiation therapy, such as the development of filtered implants, high voltage roentgen rays, and well-shielded packs containing large quantities of radium or radon. These advances have not only necessitated research into the physics of radiation but they have also removed in great part what was formerly an admissible excuse for failure of irradiation in treatment, namely, lack of sufficient facilities. Given adequate facilities, the proper application of irradiation is largely a matter of dosage, the best conceived dose in this case meaning that the required quantity of biologically effective energy is delivered to the neoplastic mass with the least injury to the adjacent normal structures and to the organism as a whole.

The quantity of energy delivered is dependent on the physical characteristics of the radiating source, such as strength, time, distance, filter, area, etc., and a statement of these factors, which we will call the "applicator dose," must measure the mechanical phase of the treatment. The applicator dose can, however, in no way express what goes on within the tissues. It may be that a certain applicator dose will produce an erythema of the skin and some other definite effect at a given depth (say 5 cm.) below the skin surface, but a similar skin effect with another applicator or with the same applicator at a different distance will produce an entirely different effect at the same depth.

The effect produced either at the skin surface or at a depth below depends upon the quantity of energy which reaches it, and this quantity we will call the "tissue dose." As radiations, from their very nature, cannot be made absolutely uniform in distribution throughout any volume, the tissue dose cannot be truly stated for any mass but only for a point. But since in cancer therapy we must deal almost entirely with masses, we may be permitted to consider the tissue dose of a given volume as of that point within it which receives the smallest quantity of energy. It is the neoplastic cells at this point which must receive at least a lethal dose in order that the entire mass may be destroyed. Other portions of the mass will receive much greater quantities of radiant energy, but this in no way alters the significance of the portions which receive the minimum dose.

Obviously the nature and degree of the effect might vary with the quality of the radiation. We may be excused however for disregarding this separate problem in the present study, since in the cases hereafter reported, we have used practically only gamma radiation from radium and high voltage roentgen rays, whose differences in effect on tissue are to all intents and purposes indistinguishable both clinically and histologically. The objection might also be raised that we have not sufficiently considered the reaction of the various normal tissues comprising the tumor bed. The mode of action of radiation in destroying neoplastic tissue is still in dispute.[1,5,6,7] It seems to us, however, that the available evidence is in favor of the primary or principal effect being due

* Read at the Fourteenth Annual Meeting, American Radium Society, Portland, Oregon, July 8–9, 1929.

to a direct action on the neoplastic cell itself, rather than to an indirect one through a reaction in the surrounding normal tissues and invading cells from the blood stream. We prefer, however, to leave this controversial question, if it will but be admitted that a specific irradiation effect in a given case will require a definite quantity of radiation, with less than which this specific effect cannot be obtained. In this discussion we are concerned with the quantities of radiation necessary to produce the most vital of all irradiation effects, namely, destruction of neoplastic tissue.

In suitable cases, neoplastic masses may be quite accurately measured in all dimensions and distances from skin portals. If the depth doses of the applicators used (both external and interstitial) are known, it is possible to calculate quite accurately the tissue dose received by the neoplastic mass. We will then be able to state by the outcome of the case that such a dose was or was not sufficient to destroy a specific neoplasm. Obviously such a statement must take into consideration the time (in days) over which the treatment extended. If several different applicators are used (which is often the case) they can seldom be used on the same day, nor is it the common opinion that heavy treatment should be given within too short a space of time. Permanently buried implants take ten to twelve days to deliver the major portion (85 to 90 per cent) of their total energy.

For the measurement of tissue dosage it is obvious that a specific unit should be employed and there is at present none entirely satisfactory. Such a unit could be either biological or physical. The "r" unit recently adopted by the Second International Congress of Radiology was established for roentgen rays, though it may later be extended to gamma rays. However, although the unit has been adopted, the practical method for its use is not yet agreed upon. It is essentially a measurement of the ionization of air and such a physical phenomenon will not necessarily indicate the degree of the subsequent biological reaction. It yet remains to be proved if doses measured by such a physical unit will produce the same biological effect for the various qualities of rays from radium and roentgen rays used therapeutically. For the measurement of tissue dosage at the present time, the only logical unit must be biological. Various experimenters have used such biological indicators as drosophila or ascaris eggs, seed shoots and tumor cells in vitro to compare the reaction of external irradiations from radium and roentgen rays. No one has however defined a satisfactory unit. Applicator doses in terms of any biological unit used in this study must be determined experimentally for all the various applicators used in the treatment of cases to be compared. Tissue doses in terms of this unit must be determined for the various depths below the skin surface at which a neoplastic mass may lie. Such a unit, the "threshold erythema" dose, is as yet the standard biological unit at Memorial Hospital and is defined as that dose which in 80 per cent of the cases treated produces a faint reddening or bronzing of the skin in from ten to twenty days and in the other 20 per cent produces no visible effect. We admit that this unit is not entirely satisfactory, but believe that there is not a better one available at present. The doses delivered at any depth below the skin surface, in percentages of that falling on the skin, have, therefore, been determined. The curves of Figure 1A show these depth doses for the radiations used in the cases discussed in this paper. The threshold erythema doses for these radiations are:

1. Roentgen rays, 50 cm. target-skin distance, 100 sq. cm. area, 0.5 mm. Cu plus 2.5 mm. Al filter.

185 kv., 30 ma. water-cooled tube—12 minutes.

200 kv., 4 ma. air-cooled tube— 70 minutes.

2. Roentgen rays, 165 kv., 30 cm. target-

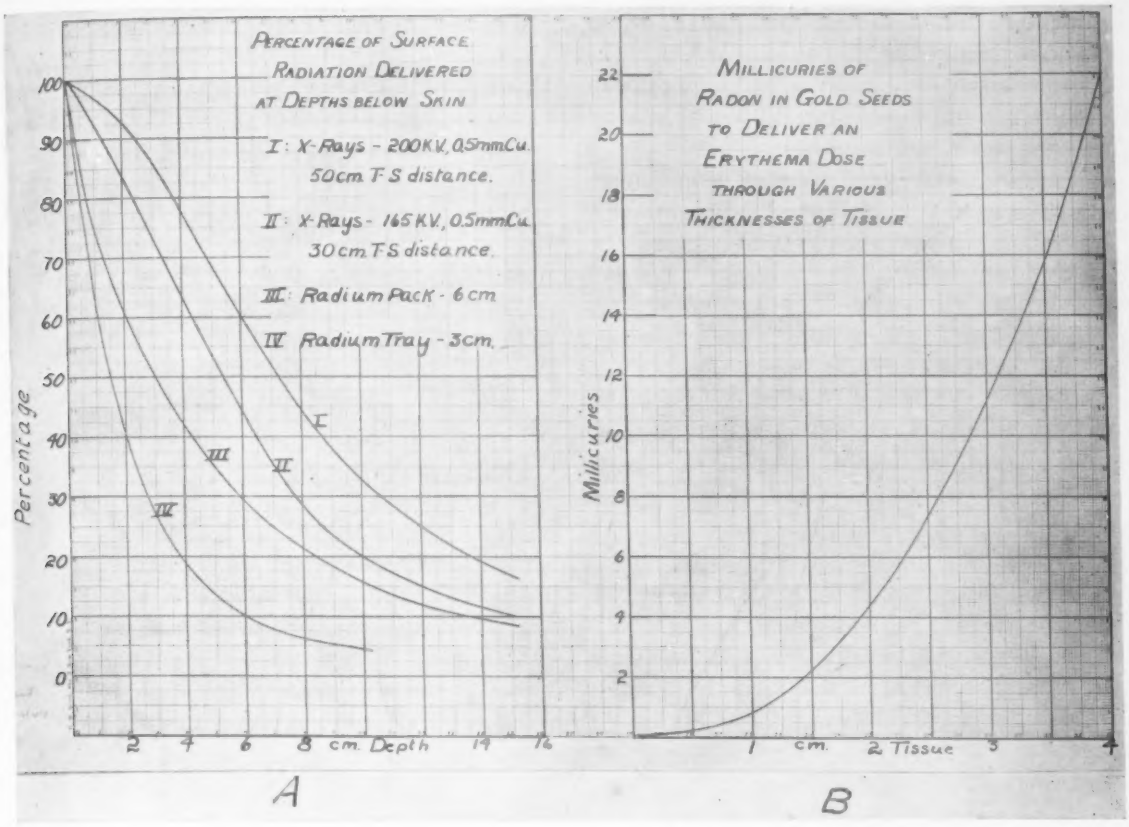
Percentage of Surface Radiation Delivered at Depths below Skin
I: X-Rays - 200 KV, 0.5 mm Cu 50 cm. T.S. distance.
II: X-Rays - 165 KV, 0.5 mm Cu 30 cm. T.S. distance.
III: Radium Pack - 6 cm.
IV Radium Tray - 3 cm.
Percentage
cm. Depth
A
Millicuries of Radon in Gold Seeds to Deliver an Erythema Dose through Various Thicknesses of Tissue
Millicuries
cm. Tissue
B

Fig. 1. A.—Depth dose curves for external irradiation sources. B.—Curves showing number of millicuries of radon in gold seeds necessary to deliver an erythema dose through various thicknesses of tissue.

skin distance, 100 sq. cm. area, 0.5 mm. Cu plus 2.5 mm. Al filter (plus 5 cm. oil), 30 ma.—5 minutes.

3. Radium element pack, 6 cm. radium-skin distance, 50 sq. cm. area of radiating surface, 0.5 mm. Pt plus 2 mm. brass filter —12,000 mg-hr.

4. Radium tray, 3 cm. radium-skin distance, 24 sq. cm. area of radiating surface, 2 mm. brass filter—2200 mc-hr.

If a threshold erythema dose is delivered with any one of these, the tissue dose at any depth may be read directly from the curve. Thus, for the radium element pack, at 6 cm. radium-skin distance 30 per cent of the skin dose is delivered at a depth of 6 cm. If only a part of a dose is given, the curve reading must be reduced in the proper ratio. Thus, if only 10,000 mg-hr. is given with the element pack, we have used only 10,000/12,000 of a threshold erythema dose. Then the dose at 6 cm. depth would be $10{,}000/12{,}000 \times 30 = 25$ per cent. All the depth doses due to external irradiation hereafter mentioned were obtained by this method.

For gold seeds, the procedure is not quite so simple. In this case, the strength of implant necessary to produce an erythema at any given distance through tissue has been determined.[3] A curve giving these values is shown in Figure 1B. From this curve, for instance, it is found that the strength of implant necessary to deliver an erythema dose at a distance of 2 cm. is 4.5 mc. Now, if 7 mc. had actually been used, the dose at 2 cm. would have been $7/4.5 = 155$ per cent of an erythema. For calculating the dose delivered at the periphery of a given mass by seeds buried

within it, we have made use of the observation previously published by us[4] that for practical purposes the surface of a sphere is equally well irradiated by a given quantity of radon whether it be concentrated at the center or divided among several tubes uniformly distributed throughout the inner 2/3 of the mass. We have considered every lesion as a sphere whose diameter is the largest dimension of the given mass, and have made our calculations as though all the radon were concentrated at the center. For instance, if in a lesion $1 \times 2 \times 3$ cm., 20 mc. in gold seeds were used, we would consider that as a sphere 3 cm. in diameter, or 1.5 cm. in radius. From the curve, the erythema dose for 1.5 cm. is 2.2 mc. Therefore 20 mc. would deliver at this distance $20/2.2 = 900$ per cent erythema dose.

In general, it is simpler to use a table to determine such doses than to read them from a curve. Accordingly in Table A we present the number of millicuries necessary to deliver specified doses in masses of various diameters. For instance, in a mass 3 cm. in diameter we can read directly that 20 millicuries deliver 9 erythema doses (900 per cent S.E.D.).*

Of course we realize that this method is not absolutely accurate. Most of the lesion doubtless receives a much greater dose. But, as stated above, we are interested in the *minimum* rather than the average dose, and this is approximately what we obtain in this manner.

Another obvious discrepancy in our doses is that, whereas we are finding the peripheral dose due to the buried radon, for external irradiation we are finding the dose at the center of the mass. The error introduced thus is unimportant for lesions of the size with which we are dealing, for

* We do not claim accuracy better than 10 per cent on these interstitial dosage data. The uncertainty of such factors as exact size of the mass and placing of the seeds may be much greater than this. While admitting these possibilities of error, we still believe that the use of such data makes possible a much more rational method of treatment and study of cases than anything heretofore offered.

TABLE A

MILLICURIES IN GOLD SEEDS REQUIRED TO DELIVER SPECIFIED DOSES TO MASSES OF VARIOUS DIAMETERS

Skin Erythema Doses	Diameter of Mass—Centimeters										
	1.0	1.5	2.0	2.5	3.0	3.5	4.0	4.5	5.0	5.5	6.0
	Number of Millicuries										
1	0.3	0.5	0.8	1.4	2.2	3.2	4.4	5.7	7.4	9.2	11
2	0.6	1.0	1.6	2.8	4.4	6.4	8.8	11	15	18	22
3	0.9	1.5	2.4	4.2	6.6	9.6	13	17	22	28	33
4	1.2	2.0	3.2	5.6	8.8	13	18	23	30	37	45
5	1.5	2.5	4.0	7.0	11	16	22	28	37	46	56
6	1.8	3.0	4.8	8.4	13	19	26	34	44	54	67
7	2.1	3.5	5.6	9.8	15	22	31	40	52	63	78
8	2.4	4.0	6.4	11	18	26	35	46	59	73	90
9	2.7	4.5	7.2	13	20	29	40	51	66	82	101
10	3.0	5.0	8.0	15	22	32	44	57	74	92	112

the dose from external radiation is fairly uniform throughout the volume of the tumor in all these cases.

Not all cases of cancer seem suitable at present for this study. We have limited ourselves strictly to those cases in which the primary lesion could be measured in its dimensions and distances from skin portals. We have likewise considered only metastases which occurred within the beam of external radiation from the skin portal. Neoplasms of the oral cavity and larynx, because of their ready inspection and measurement from the skin portals, offer a very convenient group for this investigation. A successful outcome is not an essential qualification for a case in this type of investigation. It will be of equal importance to determine sublethal and lethal doses in order to establish the average comparative radiosensitivity of any specific class of neoplasms. The dose received by a successfully treated case may be more than would have been required to destroy the neoplasm, hence we may only say that such a dose is either lethal or superlethal. If the neoplasm is not destroyed we may however be certain that the dosage received was insufficient or sublethal. At present we may only state that the lethal doses for certain neoplasms in specific cases are below or above a certain quantity, or in the exceptional case such as one given below, that it lies between two limits. We propose to give details of 10 cases in which tissue doses have been calculated, and discuss the conclusions which may later be drawn from a larger number of cases which we are now compiling and hope to publish later.

TABLE I

INTERSTITIAL IRRADIATION WITH GOLD SEEDS

(4–5 mm. in length, 0.75 mm. in diameter, 0.3 mm. gold filter)

	Date	Millicuries	Location
(1)	7–19–26	20.0	primary lesion in the left floor of the mouth
(2)	7–28–26	9.5	node over left carotid bulb

EXTERNAL RADIUM IRRADIATION WITH EMANATION PACK

	Date	Millicurie-hours	Radiating area sq. cm.	Filter	Distance in cm.	Location
(3)	7–19–26	10,000	96	2 mm. brass	6	left neck
(4)	7–24–26	10,000	96	2 mm. brass	6	right neck

EXTERNAL IRRADIATION WITH ROENTGEN RAYS

	Date	Time in minutes	Voltage (peak) kv.	Filter	Target skin distance in cm.	Ma.	Location
(5)	7–20–26	60	200	0.5 mm. Cu 1.0 mm. Al	50	4	right neck
(6)	7–22–26	60	200	0.5 mm. Cu 1.0 mm. Al	50	4	left neck

CASE I.* A. A., male, aged seventy-four, first seen in July, 1926, had noted an ulcerated lesion in the left floor of the mouth two months previously.

Examination revealed an ulcerated granular lesion in the left floor of the mouth, extending to, but not involving the under surface of the tongue. Its size was 2×3 cm. and it was centered about opposite the second left bicuspid tooth. Over the left carotid bulb, there was a hard node about 2×2.5 cm. There was no other adenopathy. A biopsy was reported as "squamous carcinoma, grade 3."

He was irradiated as shown in Table I.

Following this irradiation there was a marked reaction (blistering) at the site of the primary lesion and over the skin of the neck. The primary lesion and the node over the left carotid bulb promptly regressed and did not recur.

In October, 1926 (three months after the irradiation) a node about 1 cm. in diameter was first noted in the left submaxillary region and intimately associated with the anterior pole of the submaxillary salivary gland. This node, which was not present at the time of beginning treatment, was observed to increase in size and on November 8, 1926, a left submaxillary dissection was done. A histological section of this node was reported as follows: "Squamous carcinoma, infiltrating, grade 3, in lymph node and infiltrating a dense fibrous capsule. Marked radiation sclerosis." The patient has shown no further evidence of disease up to the present writing (June, 1929).

Comment: A case of squamous carcinoma of the floor of the mouth with metastasis to a node over the carotid bulb was irradiated with a combination of interstitial irradiation by gold filtered implants, external radium packs and roentgen rays. All radiation was given within a period of ten days. Both primary lesion and the node over the carotid bulb regressed and have not recurred (three years). A node, not present at the time of the irradiation, developed about three months later and increased in size under observation. It was removed and proved

* This case has been previously reported.[2]

TABLE II

TISSUE DOSES DELIVERED IN THREE LOCATIONS IN CASE I

	Source of radiation	Location	Primary lesion			Metastatic node over carotid bulb			Site of later submaxillary metastasis		
			Distance from source of radiation		Tissue dose (in per cent of skin erythema)	Distance from source of radiation		Tissue dose (in per cent of skin erythema)	Distance from source of radiation		Tissue dose (in per cent of skin erythema)
			through air (cm.)	through tissue (cm.)		through air (cm.)	through tissue (cm.)		through air (cm.)	through tissue (cm.)	
(1)	20 mc. gold seeds	primary lesion		1.5	870		5.0	55		3.5	125
(2)	9.5 mc. gold seeds	node over carotid bulb		5.0	25		1.25	680		3.5	60
(3)	10,000 mc-hr. pack	left neck	6	3.5	40	6	1.0	65	6	0.5	65
(4)	10,000 mc-hr. pack	right neck	6	7.5	20	6	10.0	15	6	7.0	20
(5)	x-rays 60 minutes	right neck	50	7.5	40	50	10.0	25	50	7.0	40
(6)	x-rays 60 minutes	left neck	50	3.5	70	50	1.0	85	50	0.5	75
	Total				1065			925			385

to be carcinomatous. We must therefore conclude that a nest of metastatic cells was present at the site of this node at the time of the irradiation, and that, in spite of the treatment, they not only remained viable but were capable of rapid growth.

A calculation* of the tissue dosage received at the site of this node would indicate a sublethal dose for this particular neoplasm. Calculations of the tissue doses received by the primary lesion and the metastatic node over the carotid bulb would indicate the lethal or superlethal dose (Table II).

Conclusions: It is thus shown that about 4 times a skin erythema dose of radiation reached a group of metastatic cells of squamous carcinoma, despite which they not only remained viable but were capable of rapid growth. A larger dose caused permanent regression of the primary lesion and of a separate metastasis. Since the metastatic node over the carotid bulb regressed with a dose of about 9 S.E.D. (skin erythema dose) we may assume that the lethal dose of this particular specimen of grade 3 squamous carcinoma lies between 4 and 9 times a skin erythema dose if given within a period of ten days. If the assumption of the definite neoplastic character of the neck node is objected to as not being based on histological section, the lethal or superlethal dose may be cal-

* It does not seem advisable to enter into an extended study of the possibilities of error in these calculations, but some mention of them should be made. The error in the dosage from external sources is negligible. The variations due to different possible placings of the gold implants in the primary lesion and the original metastatic node have been investigated. It seems reasonable to suppose that all the implants were at least placed within the mass for which they were intended. Instead of assuming that all of them acted as though they were at the center of the mass in question, several extreme cases were supposed. The two of most interest are when all the implants are as near as possible to the site of the secondary metastasis, and when they are as far as possible from it. In the first case, the dose at the point of the later growth would have been 5 S.E.D., and in the second, 3.35 S.E.D., instead of 3.85 as we have calculated from a supposed correct placement. This represents an extreme deviation of 30 per cent from our figures as reported. This is not negligible, but is small in comparison to common differences in radiation dosage. Therefore we feel that the lower limit as given for this particular neoplasm is fairly accurate. Great variations may occur in the upper limit for the primary growth and first node, due to different spacings of the implants. But in this case we are more interested in the fact that permanent regression resulted, and have calculated the greatest dose the tissues could have received with the radiation used.

TABLE III

EXTERNAL IRRADIATION WITH RADIUM EMANATION PACK

	Date	Applicator	Millicurie-hours	Radiating area in sq. cm.	Filter	Distance (cm.)	Location
(1)	1-21-26	tray	2,500	28	2 mm. brass	3	rt. side larynx
(2)	1-27-26	tray	2,500	28	2 mm. brass	3	lt. side larynx
(3)	2-8-26	pack	10,000	96	2 mm. brass	6	rt. side neck
(4)	2-9-26	pack	10,000	96	2 mm. brass	6	lt. side neck

EXTERNAL IRRADIATION WITH X-RAYS

	Date	Time in minutes	Voltage (peak) kv.	Filter	Target skin distance in cm.	Ma.	Location
(5)	1-25-26	60	200	0.5 mm. Cu 1.0 mm. Al	50	4	right neck
(6)	1-27-26	60	200	0.5 mm. Cu 1.0 mm. Al	50	4	left neck

culated from the primary lesion and then lies between 4 and 11 S.E.D.

CASE II. F. C., male, aged fifty-nine, first seen in January, 1926, had complained of hoarseness for the past nine months and a "sore" throat for the past three months.

Examination revealed an ulcerating granular lesion involving the right edge of the epiglottis, obliterating the right glosso-epiglottic fossa and extending down along the right ary-epiglottic fold almost to the arytenoid. In the right neck just below the right ear and underlying the anterior edge of the sternomastoid was a firm movable node about 1.5 cm. in diameter. There was no other adenopathy. Biopsy was reported as "transitional cell carcinoma, grade 3." He was treated by external irradiation alone. The applicator doses are given in Table III.

Shortly after beginning this irradiation he became dyspneic and on February 5, 1926, a tracheotomy was done and treatment continued. On February 16 (about three weeks after treatment was begun), the mass within the larynx had entirely disappeared though the radiation effect was not as yet at its height. The skin reaction of the neck went on to vesiculation but cleared up within a period of six weeks. The tracheotomy tube was left in place for some months as a safe-guard, though it was left corked after the acute reaction had subsided and was removed in July, followed by spontaneous healing of the tracheotomy wound. He has remained free from any evidence of carcinoma up to the time of the present writing.*

Comment: A case of extrinsic carcinoma of the larynx with probable metastases to the neck was treated with external irradiation alone, consisting of roentgen rays, radium packs and trays. All radiation was given within a period of twenty days. The lesion regressed and has not recurred.

A calculation of the tissue dose delivered to the primary lesion in this case would indicate the limit below which the lethal dose of this particular neoplasm must lie. As the neck node received a much larger dose, followed by regression, this dose is not pertinent to the present discussion (Table IV).

* In January, 1929, this patient developed general adenopathy (neck, axillae, groins, mediastinum). A neck node removed showed lymphosarcoma on histological section. Regression of all nodes and the mediastinal mass promptly occurred under very moderate roentgen irradiation. Recently he has developed skin metastases which also show lymphosarcoma on histological section. All histological specimens have been carefully reviewed and there is no question as to the existence of two distinct neoplastic diseases in this case.

TABLE IV

TISSUE DOSE RECEIVED BY THE PRIMARY LESION IN CASE II

	Source of radiation	Location	Distance (centimeters) from center of primary lesion		Tissue dose received by primary lesion (in per cent of a skin erythema dose)
			Through air (cm.)	Through tissue (cm.)	
(1)	tray 2,500 mc-hr.	right side larynx	3	3	25
(2)	tray 2,500 mc-hr.	left side larynx	3	4	20
(3)	pack 10,000 mc-hr.	right side neck	6	3	40
(4)	pack 10,000 mc-hr.	left side neck	6	4	35
(5)	x-rays, 60 minutes	right side neck	50	3	75
(6)	x-rays, 60 minutes	left side neck	50	4	65
					Total 260 per cent

Conclusions: It thus appears that the lethal dose for this particular specimen of transitional cell carcinoma is less than or equal to 2.6 S.E.D. given within a period of twenty days.

Case III. P. M., male, aged seventy-one, applied at Memorial Hospital for treatment October 4, 1927. He had noted a sense of fullness in the right side of his throat for three months. There had been some interference with swallowing due to coughing while eating.

Examination revealed a punched-out ulcer about 1 cm. in diameter at the right base of the tongue just above the glosso-epiglottic fossa. Filling in the glosso-epiglottic fossa, involving the right edge of the epiglottis and extending down the right ary-epiglottic fold to the arytenoid and the pyriform sinus there was a submucous non-ulcerated mass about 2×2.5 cm. in diameter. There was no adenopathy.

Biopsy was reported as follows: "Very difficult to distinguish between transitional cell carcinoma and lymphosarcoma. Atypical epidermis strongly favors transitional cell carcinoma."

He was treated with external irradiation only—radium packs and trays, and roentgen rays. It will be noted that this case seems almost identical in the location of the primary lesion and in its histological picture with Case II. For this reason an attempt was made to duplicate exactly the irradiation given in Case II. The applicator doses are given in Table V. Following this irradiation there was a severe skin reaction of the neck and a rather prompt initial regression of the primary lesion, followed by healing of the ulcer at the base of the tongue. When the edema subsided there was noted a persistent fullness in the right glosso-epiglottic fossa and adjacent right edge of the epiglottis. This fullness seemed about 1 cm. in diameter. It remained unchanged for about

Table V

EXTERNAL IRRADIATION WITH RADIUM ELEMENT PACK

	Date	Applicator	Milligram-hours	Radiating area in sq. cm.	Filter	Distance in cm.	Location
(1)	10-9-27	element pack	15,000	50	2.0 mm. brass 0.5 mm. platinum	6	rt. neck
(2)	10-13-27	element pack	15,000	50	2.0 mm. brass 0.5 mm. platinum	6	lt. neck
(3)	10-27-27	tray	2,500	28	2.0 mm. brass	3	lt. neck (directed toward epiglottis)
(4)	10-27-27	tray	2,500	28	2.0 mm. brass	3	rt. neck (directed toward epiglottis)

EXTERNAL IRRADIATION WITH ROENTGEN RAYS

	Date	Time in minutes	Voltage (peak) kv.	Filter	Target skin distance in cm.	Ma.	Location
(5)	10-18-27	60	200	0.5 mm. Cu 1.0 mm. Al	50	4	right neck
(6)	10-20-27	60	200	0.5 mm. Cu 1.0 mm. Al	50	4	left neck

six months, but in July, 1927, it ulcerated and a biopsy taken at that time was reported as "squamous carcinoma, grade 2." From this time onward the patient rapidly went downhill, required a tracheotomy in September and died November 8, 1928.

Conclusions: The location of the primary lesion, the measurements of the neck and the irradiation were almost exactly the same as in Case II and the primary lesion thus received 2.6 S.E.D. given within a period of nineteen days. In view of the two different pathological reports it seems fair to assume that different portions of this growth were of different characters. The ulcer from which the original biopsy was taken and the major bulk of the lesion regressed promptly under irradiation with a tissue dose of 2.6 S.E.D. A small mass persisted however and later proved to be squamous carcinoma, grade 2. The persistence of a more radioresistant portion of a neoplasm may account for some of the apparent increased radioresistance or "vaccination" of unsuccessfully irradiated neoplasms.

CASE IV. P. H., male, aged sixty, was referred to Memorial Hospital, March 3, 1928. About a year previously he had noted a mass in the right side of the neck and six months later a mass in the left neck. Three months before admission he had developed hoarseness and cough.

Examination revealed an ulcerated granular lesion about 2 cm. in diameter involving the outer surface of the right ary-epiglottic fold and extending into the right pyriform sinus. Over the right carotid bulb there was a moderately hard node about 2.5×4 cm. in diameter and over the left carotid bulb a node 1.5×3 cm. in diameter.

A biopsy was reported as "transitional cell carcinoma."

He was treated with external irradiation only by element pack and roentgen rays. The applicator doses are given in Table VI.

Between 4-10-28 and 4-24-28 (fourteen days)

TABLE VI

EXTERNAL IRRADIATION BY RADIUM ELEMENT PACK

Date	Milligram-hours	Radiating area in sq. cm.	Filter	Distance in cm.	Location
3-20-28	8000	50	0.5 Pt 1.5 brass	6	rt. neck
3-23-28	4000	50	0.5 Pt 1.5 brass	6	rt. neck
3-23-28	9000	50	0.5 Pt 1.5 brass	6	lt. neck
3-25-28	7000	50	0.5 Pt 1.5 brass	6	lt. neck
3-29-28	4000	50	0.5 Pt 1.5 brass	6	rt. neck

EXTERNAL IRRADIATION WITH ROENTGEN RAYS

Dates	Time in minutes	Voltage (peak) kv.	Filter	Target skin distance in cm.	Ma.	Location
Eight treatments between 4-10-28 and 4-24-28	4	185	0.5 mm. Cu 1.0 mm. Al	50	30	alternate sides of neck

eight roentgen-ray treatments, as outlined above, were given—four to each side of the neck. The entire treatment by both roentgen rays and radium was given within a period of thirty-three days.

Following this irradiation there was dryness, epilation and scaling of the skin of the neck but no blistering. The neck nodes became definitely smaller and the ulceration within the larynx became distinctly less. Three months later the neck nodes were still definitely palpable and ulceration could still be seen in the larynx. In June, 1928, the patient's general condition became such that he did not feel able to make the long trip to the clinic and from the subsequent Social Service investigations it seems that the disease progressed rapidly within the larynx and he died in August, 1928.

Comment: A case of transitional cell carcinoma of the larynx with probable metastasis to the neck was treated with external irradiation alone by roentgen rays and radium over a period of thirty-three days. The disease was not controlled and the patient died three months later.

A calculation of the tissue doses received by the primary lesion and neck nodes would indicate a sublethal dose for this neoplasm. These calculations are given in Table VII. As the nodes on each side of the neck obviously received equal quantities of radiation, the calculations for the one on the right only are given.

Conclusions: A case of transitional cell carcinoma of the larynx was treated over a period of thirty-three days by external irradiation (roentgen rays and radium), the primary lesion receiving approximately 2.50 and neck nodes 2.85 S.E.D. as a tissue dose. This dosage given over a period of thirty-three days was not sufficient to destroy this particular specimen of transitional cell carcinoma.

Case V. J. D., male, aged seventy-five, reported to Memorial Hospital, May 8, 1928. Two months previously he had become conscious of a mass at the base of the tongue which had caused him slight discomfort, especially on swallowing.

Examination revealed a soft non-ulcerated mass about 2.5 × × 4 cm. whose long diameter lay across the base of the tongue in the midline just in front of the epiglottis. There was

Table VII

TISSUE DOSES RECEIVED IN THE PRIMARY LESION AND NECK NODES IN CASE IV

Source of radiation	Location	Primary lesion			Node right neck		
		Distance from source of radiation		Tissue dose (in per cent of skin erythema)	Distance from source of radiation		Tissue dose (in per cent of skin erythema)
		Through air (cm.)	Through tissue (cm.)		Through air (cm.)	Through tissue (cm.)	
Element pack (Total—16,000 mg-hr.)	right neck	6	4	55	6	1	100
Element pack (Total—16,000 mg-hr.)	left neck	6	7	30	6	10	20
X-rays (Total—16 minutes)	right neck	50	4	105	50	1	120
X-rays (Total—16 minutes)	left neck	50	7	60	50	10	45
Total				250%			285%

no adenopathy. Biopsy was reported as "malignant tumor; lymphosarcoma or lympho-epithelioma."

He was treated by external irradiation only with element packs.

Eight treatments of 8000 mg-hr. each were given over a period of twenty days—four to each side of the neck, which totaled 32,000 mg-hr. to each side.

Following this irradiation the skin of the neck showed a moderate erythema, with subsequent epilation and dryness of the skin. The mass at the base of the tongue had completely disappeared within ten days after completion of the treatment, and did not recur, nor were there any later signs of metastases. The patient was very feeble on admission and though he showed no signs of recurrence he died suddenly four months later, evidently from old age.

Conclusions: A case of lymphosarcoma or lympho-epithelioma of the base of the tongue was treated by external irradiation alone. The lesion promptly regressed.

Calculation of the dosage received by the primary lesion demonstrated that the minimum dose (center) was 135 per cent of a skin erythema dose. This response to 135 per cent S.E.D. over a period of twenty days indicates an extremely radiosensitive tumor.

CASE VI. G. L., male, aged seventy-three, applied at Memorial Hospital in December, 1926. He gave a history of having noted a mass in the upper left neck several months previously and two weeks prior to admission had accidentally noted a mass in the left side of the tongue. Neither had caused any symptoms.

Examination revealed an ulcerated and indurated ovoid mass in the left edge of the tongue opposite the base of the left anterior tonsillar pillar. Its size was 2×3×1.5 cm. Over the left carotid bulb there was a movable hard mass about 3×3×2 cm. in diameter. There was no other adenopathy. Histological examination of a biopsy of the tongue lesion was reported as "squamous carcinoma, grade 2." He was treated by a combination of interstitial irradiation and external irradiation by radium and roentgen rays—all given within a period of sixteen days. The applicator doses are given in Table VIII.

TABLE VIII

EXTERNAL RADIUM IRRADIATION WITH EMANATION PACK
(The physical factors are the same as for the pack in Table 1)

	Date	Millicurie-hours	Location
(1)	12–18–26	10,500	left neck
(2)	12–19–26	10,000	right neck

EXTERNAL IRRADIATION WITH ROENTGEN RAYS
(The physical factors are the same as for the roentgen rays in Table 1)

	Date	Time in minutes	Location
(3)	12–21–26	60	right neck
(4)	12–22–26	60	left neck

INTERSTITIAL IRRADIATION WITH GOLD SEEDS
(For physical characteristics see Table 1)

	Date	Millicuries	Location
(5)	12–29–26	20	primary lesion
(6)	1– 3–27	22	node over left carotid bulb

Following this irradiation there was a marked reaction both at the site of the primary lesion and over the skin of the neck, especially in the vicinity of the neck node. There was prompt regression of the mass in the tongue followed soon thereafter by complete disappearance of the neck node. Neither has recurred up to the time of the present writing and the patient remains in excellent health (two and a half years).

Comment: A case of squamous carcinoma of the tongue with metastasis to the neck was treated with a combination of interstitial irradiation and external irradiation by roentgen rays and radium. The disease promptly regressed and has not recurred. A calculation of the tissue doses received by both primary lesion and metastases

would indicate the lethal or superlethal dose of this neoplasm. These calculations are given in Table IX.

Conclusions: This case of squamous carcinoma, grade 2, of the tongue with neck metastasis was relieved and has remained free from disease for three years under a tissue dose of about 11–12 S.E.D. given within sixteen days. It is interesting to note that it agrees quite well with Case I in its clinical setting, dosage, and final outcome.

Case VII. W. M., male, aged thirty-three, entered the clinic at Memorial Hospital in October, 1926, complaining of dyspnea and dysphagia due to a mass in the pharynx. About four months previously he had noted a "swelling" in the right side of the throat which had progressively grown until it caused definite difficulty in swallowing and breathing. About two months before admission he had noted masses in the right side of the neck.

Examination revealed a young man in fairly good general condition, though slightly dyspneic. Arising in the region of the right tonsil and right soft palate was a pedunculated, almost spherical mass about 5 cm. in diameter which almost completely blocked the pharynx. It was ulcerated on its anterior surface. Extending forward from the carotid bulb to the submaxillary region there were several moderately hard nodes 1-2 cm. in diameter. A biopsy was reported as "transitional cell carcinoma." He was treated with external irradiation alone (Table X).

A week after beginning this irradiation (10-13-26) there was a marked diminution in the size of both the pharyngeal lesion and the neck nodes. It was thought best however to add another roentgen-ray treatment which was given on 10-16-26 as shown in Table X. Two weeks from the beginning of the treatment

Table IX

TISSUE DOSES DELIVERED IN THE PRIMARY LESION AND NODE IN CASE VI

Source of radiation	Location	Primary lesion			Metastatic node over left carotid bulb		
		Distance from source of radiation		Tissue dose (in per cent of skin erythema)	Distance from source of radiation		Tissue dose (in per cent of skin erythema)
		Through air (cm.)	Through tissue (cm.)		Through air (cm.)	Through tissue (cm.)	
(1) 10,500 mc-hr. pack	left neck	6	2.5	60	6	2.0	60 (comparatively less than primary because off center)
(2) 10,000 mc-hr. pack	right neck	6	7.0	25	6	8.0	20
(3) X-rays 60 minutes	right neck	50	7.0	45	50	8.0	40
(4) X-rays 60 minutes	left neck	50	2.5	75	50	2.0	80
(5) 20 mc. gold seeds	primary lesion		1.5	870		4.0	90
(6) 22 mc. gold seeds	left neck node		4.0	100		1.5	955
Total				1175			1045

TABLE X

EXTERNAL RADIUM IRRADIATION WITH EMANATION PACK

(The physical factors are the same as for the pack in Table 1)

	Date	Millicurie-hours	Location
(1)	10–10–26	10,000	angle of right mandible directed toward tonsil

EXTERNAL IRRADIATION WITH ROENTGEN RAYS

	Date	Time in minutes	Voltage (peak) kv.	Filter	Target skin distance in cm.	Ma.	Location
(2)	10–7–26	14	185	0.5 mm. Cu 1.0 mm. Al	50	30	angle of right jaw toward tonsil
(3)	10–16–26	80	200	0.5 mm. Cu 1.0 mm. Al	50	4	angle of right jaw toward tonsil

there was complete disappearance of both the primary lesion and neck nodes. There has been no recurrence up to the time of this writing (June, 1929).

Comment: A case of transitional cell carcinoma arising from the right tonsillar region with metastasis to the neck was treated with external irradiation alone—radium packs and roentgen rays. All irradiation was given within a period of nine days. The primary lesion and the neck nodes began to decrease markedly in size within a week after beginning treatment and had completely regressed after two weeks. He has remained free from disease up to the present time (two years and eight

TABLE XI

TISSUE DOSES RECEIVED IN THE PRIMARY LESION AND NODE IN CASE VII

	Source of radiation	Location	Primary lesion			Nodes right neck		
			Distance from source of radiation		Tissue dose (in per cent of skin erythema)	Distance from source of radiation		Tissue dose (in per cent of skin erythema)
			Through air (cm.)	Through tissue (cm.)		Through air (cm.)	Through tissue (cm.)	
(1)	Pack, 10,000 mc-hr.	over right tonsil	6	5	35	6	2.5	55
(2)	X-rays, 14 minutes	over right tonsil	50	5	80	6	2.5	105
(3)	X-rays, 80 minutes	over right tonsil	50	5	80	6	2.5	105
	Total				195			265

months). The tissue dosage of this extremely radio-sensitive neoplasm has been calculated in Table XI. The tissue dose of the primary lesion (which received a lesser intensity) is taken as the lethal or superlethal dose.

Conclusions: This neoplasm has been the most radiosensitive transitional cell carcinoma in our experience both in the short period in which a rapid regression began and in that it has apparently been permanently destroyed by about 2 S.E.D. given in nine days.

Case VIII. H. K., male, aged forty-seven, applied at Memorial Hospital in June, 1927, complaining of moderate dyspnea, dysphagia and speech difficulty. About two years previously he had first noted a mass in the left tonsillar region. During the three or four months preceding his admission the inter-

Table XII

INTERSTITIAL IRRADIATION WITH GOLD SEEDS
(Physical factors as in Table I)

	Date	Millicuries	Location
(1)	6–29–27	20 (removed with primary lesion after 10 days)	pedicle of primary lesion
(2)	7–15–27	30	metastasis left neck

EXTERNAL IRRADIATION WITH RADIUM ELEMENT PACK
(Physical factors as in Table I)

	Date	Milligram-hours	Location
(3)	6–26–27	10,000	lower extremity, left neck mass directed toward tonsil
(4)	6–28–27	10,000	upper extremity, left neck mass directed toward tonsil
(5)	7–20–27	14,000	center of left neck mass directed toward left tonsil

EXTERNAL IRRADIATION WITH ROENTGEN RAYS

	Date	Time in minutes	Voltage (peak) kv.	Filter	Target skin distance in cm.	Ma.	Location
(6)	6–29–27	5	185	1.0 mm. Cu	25	30	left neck toward tonsil

ference with breathing, swallowing and speech had gradually developed and grown worse. He had noted development of a mass in the left neck for about three months but had not consulted a physician until a few days before admission.

Examination revealed a partly ulcerated soft mass about 7 cm. in diameter completely filling the pharyngeal passage and arising from the upper pole of the left tonsil by a pedicle about 2.5 to 3 cm. in diameter. Extending forward and downward from the left carotid bulb there was a moderately hard movable mass about 4×8×12 cm. in diameter.

A biopsy was reported as "transitional cell carcinoma."

He was treated with a combination of external irradiation with radium packs and roentgen rays and interstitial irradiation with gold seeds in the primary and metastatic nodes. The gold seeds in the primary lesion were inserted after a definitely conceived plan so as to lie in one plane in the pedicle, irradiating the base from which the tumor arose at a distance of 1 to 1.5 cm. After a calculated dose from these gold seeds had been delivered, the primary tumor with its pedicle and gold seeds were to be excised. This was accomplished as planned and without difficulty. The radiation was all given within a period of twenty-four days and is summarized in Table XII.

During the course of this irradiation and ten days after insertion of 20 mc. of gold seeds into the pedicle of the pharyngeal tumor, the latter was excised by blunt dissection under general anesthesia. Gold seeds, as noted in Table XIII, were inserted into the neck metastasis at a later date after exposing the external surface of the nodes by a short incision through the skin under local anesthesia.

A marked radiation reaction occurred in the region of the left tonsil and over the skin

TABLE XIII

DOSES RECEIVED IN THE PRIMARY LESION AND METASTASIS IN CASE VIII

	Source of radiation	Location	Primary lesion			Metastasis		
			Distance from source of radiation		Tissue dose (in per cent of skin erythema)	Distance from source of radiation		Tissue dose (in per cent of skin erythema)
			Through air (cm.)	Through tissue (cm.)		Through air (cm.)	Through tissue (cm.)	
(1)	20 mc. gold seeds	pedicle of primary tumor		1.5	750		4	80
(2)	30 mc. gold seeds	left neck mass		4.0	80		3	160
(3)	10000 mc-hr. pack	left lower neck	6	6.0	30	6	2	60
(4)	10000 mc-hr. pack	left upper neck	6	5.0	35	6	3	50
(5)	14000 mc-hr. pack	left center neck	6	6.0	40	6	2	85
(6)	X-ray 5 minutes	left neck	25	7.0	45	25	2	85
	Total				980			520

of the left neck. The skin reaction regressed in about six weeks, leaving a soft pliable skin. Superficial ulceration persisted over a small area in the left tonsillar region for about four months and then healed leaving a perfectly satisfactory scar. The neck nodes had entirely regressed after about six weeks. He has remained comfortable and free of disease up to the present writing.

Comment: A case of transitional cell carcinoma of the tonsil with metastasis to the neck was treated by external and interstitial irradiation, following which the primary lesion was removed surgically. There was prompt regression and there has been no recurrence after two years.

Calculations of the tissue doses received by the primary lesion and neck nodes are given in Table XIII.

Conclusions: The minimum tissue dose which has apparently permanently destroyed this neoplasm is that received by the neck nodes which is slightly more than 5 S.E.D. This figure may then be taken as the lethal or superlethal dose if given in twenty-four days.

A critical review of this case from the viewpoint of about two years' complete freedom from disease will lead one to speculate as to whether or not this case was given unnecessarily heavy dosage considering the histological findings. It seemed to us, however, that a lesser dosage was not justified in a tumor whose long duration and clinical setting would fit so much better with one of epithelial origin. We therefore somewhat disregarded the histological picture in outlining treatment. Whether it would have responded to a lesser dosage is at present a question of academic interest only, for the local and general conditions of the patient are entirely satisfactory.

CASE IX. J. A., male, aged sixty-six, was admitted to the clinic at Memorial Hospital in May, 1927, complaining of an ulcerated mass at the left base of the tongue which he had noted two months previously.

Examination revealed a deeply buried hard mass about 2×1 cm. in diameter in the left base of the tongue about opposite the left anterior tonsillar pillar. The mucous membrane was normal over it except for an area of ulceration about 0.5 cm. in diameter. Over the left carotid bulb could be palpated a rather indefinite soft node about 1.5 cm. in diameter.

A biopsy was reported as "squamous carcinoma, grade 2".

He was irradiated externally with radium element packs and interstitially with gold seeds as follows (Table XIV):

TABLE XIV

EXTERNAL RADIUM IRRADIATION WITH ELEMENT PACK
(Physical factors as in Table V, *except that the distance was 10 cm.*)

	Date	Milligram-hours	Location
(1)	5–17–27	12,000	left submaxillary region directed toward primary lesion
(2)	5–20–27	14,000	left submaxillary region directed toward primary lesion
(3)	5–24–27	8.000	left submaxillary region directed toward primary lesion
(4)	5–27–27	8,000	left submaxillary region directed toward primary lesion

INTERSTITIAL IRRADIATION WITH GOLD SEEDS

	Date	Millicuries	Location
(5)	5–21–27	17	primary lesion in tongue

Following this irradiation there was a moderately severe local reaction at the site of the primary lesion and a redness and scaling of the skin of the neck. The primary lesion had entirely regressed and healed in about one month and he has remained free from disease up to the time of the present writing. The neck node which was indefinite at the beginning has shown no particular change.

Comment: A case of squamous carcinoma of the tongue with apparent metastasis to the neck was treated by a combination of external irradiation to the tongue and neck and interstitial irradiation to the tongue only. The disease promptly regressed and has not recurred after two years. A calculation of the tissue dose received by the primary lesion and the questionable neck node isgiven in Table XV.

Conclusions: The primary lesion in this case received a tissue dose of 22 S.E.D., an enormous quantity and undoubtedly needlessly large but it has caused no troublesome sequelae. The neck node for which the calculations show a tissue dose of but 2 S.E.D. may quite logically be assumed to have been inflammatory only.

CASE X. A. O., female, aged twenty-two (student nurse), was referred to Memorial Hospital in December, 1926. A year before her admission (December, 1925) she had noted slight hoarseness which had persisted and increased in severity until July, 1926, when she became dyspneic. The dyspnea became rapidly aggravated and in August, 1926, a tracheotomy had been performed.

Examination revealed a young woman seemingly in good general physical condition. She was wearing a tracheotomy tube which had apparently been inserted through the cricothyroid membrane. When the tracheotomy tube was removed, the larynx as seen through and above the tracheotomy wound seemed filled with an ulcerated granular mass which extended downward to the tracheotomy opening and formed a ring of ulcerated tissue surrounding the opening and raised 3–4 mm. above the level of the skin of the neck. Edema of the tissues of the hypopharynx rendered examination of the larynx by an indirect mirror of little value. There was no evidence of metastasis. The clinical appearance was that of massive neoplastic disease of the larynx modified by operation and infection. Biopsies taken from within the larynx and from the margin of the tracheotomy wound were reported as "squamous carcinoma, grade 1". In planning treatment, it was decided to rely chiefly upon interstitial irradiation, accurate placement of which necessitated surgical exposure of the lesion so as to determine its limits.

After preliminary radium packs to each side of the larynx, 20 mc. of gold seeds were inserted into the visible portions of the growth especially about the tracheotomy opening. Five days later (12-13-26) a laryngotomy was performed under superior and inferior laryngeal block and local infiltration with 1 per cent novocaine. The trachea and larynx were laid open from the hyoid bone to the suprasternal notch and the collar of neoplastic disease about

TABLE XV

TISSUE DOSES RECEIVED IN THE PRIMARY LESION AND NODE IN CASE IX

	Source of radiation	Location	Primary lesion			Neck node		
			Distance from source of radiation		Tissue dose (in per cent of skin erythema)	Distance from source of radiation		Tissue dose (in per cent of skin erythema)
			Through air (cm.)	Through tissue (cm.)		Through air (cm.)	Through tissue (cm.)	
1, 2, 3, and 4	Element pack 32,000 mg-hr. at 10 cm.	left submaxillary	10	3	100	10	2	110
5	17 mc. gold seeds	tongue		1	2100		4	85
	Total				2200			195

the tracheotomy wound excised. With this exposure the neoplastic disease was found to extend from the isthmus of the thyroid (which was infiltrated) up the anterior tracheal wall to the level of the arytenoids. The disease had infiltrated and destroyed the anterior portion of the cricoid cartilage and about the anterior half of each lamina of the thyroid cartilage. At the level of the vocal cords the disease seemed to be annular. After this surgical exposure a laryngotomy tube was inserted and the wound packed wide open with gauze. Eight days later (12-21-26) 21 mc. gold seeds were distributed throughout the mass of neoplasm as its limits had been defined by the surgical exposure. The postoperative course was not particularly severe and the patient was able to take adequate nourishment by mouth at all times. An intense local radiation reaction occurred followed by complete regression of the disease. There was no slough and after about two months, during which time the wound was packed daily, healing took place by granulation.

In its healed state the local condition simulates total laryngectomy. The trachea presents at the lower angle of the operative scar and its anterior wall is healed to the skin. Immediately above, the posterior wall of the trachea and larynx are on a level with the skin and the opening into the hypopharynx is collapsed and healed except for a sinus barely admitting a fine probe. This total collapse of the laryngeal cavity is due to the original destruction of the cartilages by disease. The patient has shown no evidence of recurrence up to the present time, is in excellent general health and is working as a laboratory technician.

The applicator doses of the radiation are given in Table XVI.

Comment: A case of carcinoma of the larynx in a female, aged twenty-two, involving the cartilages, trachea, and isthmus of the thyroid gland was treated by radium packs and interstitial irradiation after surgical exposure. The disease promptly regressed and has not recurred after two and a half years.

The tissue dose received by the neoplastic mass is calculated in Table XVII.

TABLE XVI

EXTERNAL RADIUM IRRADIATION WITH EMANATION PACK

(Physical factors as in Table 1)

	Date	Millicurie-hours	Location
(1)	12-6-26	6,000	right side of larynx
(2)	12-8-26	6,000	left side of larynx

INTERSTITIAL IRRADIATION WITH GOLD SEEDS

	Date	Millicuries	Location
(3)	12-8-26	21 (removed at operation after 5 days)	about tracheotomy opening
(4)	12-21-26	21	neoplastic mass after surgical exposure

Conclusions: The lethal dose of this particular grade 1 laryngeal squamous carcinoma has thus been calculated as being about 11 S.E.D. or less when given in fifteen days.

DISCUSSION

A tabulation of the dosage calculations in these 10 cases is given in Table XVIII. What inferences, if any, may bedrawn from these findings? The individual cases will first be reviewed.

In Case 1, which we believe to be unique from the standpoint of this problem, it is possible to define two limits between which the lethal dose of a specific neoplasm must lie. We believe that it probably lies nearer the greater than the lesser dose (compare with Cases VI and X). From the practical standpoint it seems most significant to prove that it is in reality so high. In this case, even though the skin of both sides of the neck was given an epidermicidal dose of radium radiation at 6 cm. within ten days, delivering a dose of about 4 S.E.D. to a superficial node, the latter was still capable of growth. The dosage nearer

the midline within the oral cavity was even less (2 S.E.D.). What then shall we conclude about the curative possibilities of external irradiation alone in intraoral carcinoma of definitely squamous type? If we suppose that the lethal dose of this neoplasm was 5 S.E.D. it would have required 2½ times as much external irradiation to deliver 5 S.E.D. to the midline of the tongue. Should we then not admit the impossibility of curative treatment of deep-seated squamous carcinoma by external irradiation alone?

Case II. Here external irradiation alone was used with apparent cure (three years). The possible error in these calculations is quite small. This extremely radiosensitive tumor was permanently eradicated by ⅔ of the sublethal dose given in Case I.

Case III. This lesion seemed identical in location, extent and histological nature with Case II and an attempt was made to exactly duplicate the dose. The major portion of the primary lesion regressed as in Case II, but a remaining portion persisted and finally grew sufficiently to destroy life. This remaining portion proved to be of a different and more radioresistant histological nature. Such a persistence of a more radioresistant element may account in part for the often observed phenomenon of apparent radioresistance or "vaccination" after sublethal dosage.

Case IV. The histological nature of this lesion and its clinical setting were quite similar to Cases II and III except for bilateral neck metastases. The tissue dose given was of about the same amount as in Cases II and III but it was distributed over a period of thirty-three days and unlike those cases did not produce an epidermicidal reaction to the skin. If it had been administered in twenty days or less, there would undoubtedly have been vesiculation of the skin and probably also a comparatively greater effect on the tumor.

Case V. The extreme radiosensitivity of neoplasms of this nature emphasizes the necessity for clinical observation and

TABLE XVII

TISSUE DOSE RECEIVED BY THE PRIMARY LESION IN CASE X

	Source of radiation	Location	Laryngeal neoplasm		
			Distance from source of radiation		Tissue dose (in per cent of skin erythema)
			Through air (cm.)	Through tissue (cm.)	
(1)	Emanation pack 6,000 mc-hr. at 6 cm.	right side larynx	6	5.0	20
(2)	Emanation pack 6,000 mc-hr. at 6 cm.	left side larynx	6	5.0	20
(3)	Gold seeds 20.8 mc. (removed at operation after 5 days)	about tracheotomy opening		1.5	540
(4)	Gold seeds 21 mc. (postoperative)	larynx and upper trachea		2.0	490
	Total				1070

biopsy before treatment. Dosages such as given in Case I would be entirely unjustified in one of this nature. Radiation therapy has its dangers and possible mortality as well as surgery, and in highly radioresistant lesions may, as with surgery,

TABLE XVIII

TABULATION OF TISSUE DOSAGE CALCULATIONS

	Histological diagnosis	Duration of irradiation (days)	Sublethal dose (S.E.D.)	Lethal or super-lethal dose (S.E.D.)	Result to date
Case I A.A.	intraoral squamous carcinoma, grade 3	10	3.85	9.35	well, 3 years
Case II F.C.	extrinsic transitional cell carcinoma of larynx	20	...	2.6	no recurrence of carcinoma 3½ years. Developed lymphosarcoma Jan., 1929 Under treatment
Case III P.M.	extrinsic transitional cell carcinoma of pharynx	20	...	2.6	no recurrence, 13 months
	squamous carcinoma of pharynx grade 2	20	2.6	..	recurrence, died 13 months
Case IV P.H.	extrinsic transitional cell carcinoma of larynx	33	2.5	..	incomplete regression Died of disease in 5 months
Case V J.D.	lympho-epithelioma of base of tongue	20	...	1.35	complete immediate regression. Died in 4 months without apparent recurrence
Case VI G.L.	squamous carcinoma of tongue, grade 2	16	...	10.4	well, 2½ years
Case VII W.M.	transitional cell carcinoma of tonsil	9	...	1.95	well, 2½ years
Case VIII H.K.	transitional cell carcinoma of tonsil	24	...	5.2	well, 2 years
Case IX J.A.	squamous carcinoma of tongue, grade 2	10	...	22.0	well, 2 years
Case X A.O.	squamous carcinoma of larynx, grade 1	15	...	10.7	well, 2½ years

be properly pushed to the limit of tolerance rather than permit the natural course of the disease to bring about the same end.

Case VI. This very gratifying outcome in a case of carcinoma of the tongue with metastasis to the neck demonstrates the possibilities of irradiation as compared to surgery in an operable setting. A patient of advanced years, in none too robust general condition, was relieved by irradiation alone, with very moderate discomfort, over a period of about six weeks. It should be noted that the tissue dose received corresponds very closely with Case I.

Case VII is the most radiosensitive transitional cell carcinoma in our experience. We do not believe that its lethal dose should be seriously considered as typical of this group of tumors and we therefore feel that a larger dose should be outlined and given in the average case.

Case VIII. There has been considerable discussion concerning the proper classification of this neoplasm. In the histological section it is difficult to distinguish between lymphosarcoma and transitional cell carcinoma, several competent pathologists having different opinions. However, its long duration (two years) locally in the tonsil and its late regional metastasis and apparent cure by local treatment rather argues in favor of its being of epidermoid origin. Its response to irradiation, as evidenced by complete regression under a tissue dose of a little over 5 S.E.D., is common to both types of neoplasm.

Case IX. Two significant facts are demonstrated in this case. First, that a small mass can be very intensely irradiated without particularly untoward effects. The calculated tissue dose of the tongue mass is 22 S.E.D., a figure which results from empiric dosage, based on what the clinician has learned by experience to be the maximum dose consistent with a reasonably comfortable convalescence and without breaking down of adjacent normal tissue. Secondly, we believe that regression of the questionable neck node under a tissue dose of about 2 S.E.D. indicates its benign (inflammatory) nature.

Case X. The possibilities of irradiation in an otherwise hopeless situation is here demonstrated. The outcome seems fantastic until one considers the dose delivered. Fortunately the disease had apparently remained localized and as in Cases I and VI a tissue dose of 10 S.E.D. has again apparently permanently destroyed adult squamous carcinoma. It is also interesting to note that this dosage can be tolerated by the immediately adjacent viscera in the region of the larynx.

These 10 cases are among the first with which we began this investigation about two years ago. In this preliminary report we have limited ourselves to this group in which the end-result is final (death), or of at least two years' duration. The majority of these cases are free from disease at present, which is due to the fact that at the outset we were most interested in and chose those cases which seemed to have progressed favorably. Since that time we have endeavored to measure all cases in which the limits and dimensions of the primary lesion and metastases could be definitely determined. For this problem the unsuccessful case is at present equally as significant as the successful, as it demonstrates the sublethal dose. We are at present somewhat uncertain as to the limit of time (in days) during which tissue doses may be totaled for this study. We have arbitrarily taken thirty days. Beyond this period we assume that further irradiation cannot be calculated to prove any definite degree of radiosensitivity. On the other hand, the shorter the treatment period, the more significant and valuable become the dosage data. We are often led to speculate as to whether the remote undesirable effects are not about the same whether irradiation be given within a short time or spread over a period of a month or six weeks. The reaction of the tumor, however, seems markedly increased by a shorter treatment period. Saturation

or fractional methods are not logical in the light of everyday experience. For instance, in the treatment of basal cell carcinoma with our plaques which sometimes contain 800–900 millicuries of radon, the entire treatment lasts but an hour or less. For smaller lesions treated with our unfiltered emanation bulb, the duration may be less than one minute. The skin reactions and the response are, however, entirely typical of irradiation in general and in no class of cases are the results more favorable. It must not be supposed, however, that we advise massive doses of external irradiation within a few hours. The organism as a whole is profoundly and immediately affected by massive doses and time must be given (one to four days) for recovery between these applications. We wish to emphasize our intentions to draw no definite conclusions from this small series of cases, but our clinical preference for a short treatment period seems justified by Cases I, VII and IX (ten days). It is also interesting to note that Cases I, VI, IX, and X which were squamous carcinoma of adult type all received 10 S.E.D. or more. We might add that in those of our later cases in which the immediate result indicates a similar course, about the same dosage has been delivered.

Cases II and III received probably about the limit of external irradiation to the neck from the standpoint of the patient's local and general condition. As has been previously mentioned, this bilateral applicator dose delivered only a little more than 2½ S.E.D. to the midline of the neck. A comparison of this figure with the necessary dose (10 S.E.D.) as indicated by Cases I, VI, and X should convince those who attempt the treatment of deep-seated squamous carcinoma by external irradiation alone of the futility of such attempts with present-day facilities. And it seems hardly reasonable to suppose that further developments in external irradiation facilities will alter this situation as it must always be the tissue immediately below the skin portal and the skin itself which will be affected most under any physical arrangement.

Much experimental work yet remains to be done. Our unit for tissue dosage, the threshold skin erythema, is not entirely satisfactory. Nothing very definite is known concerning the influence of the treatment interval as it applies to the variations in tumor destruction and normal tissue tolerance. However, we believe that both these problems will be at least partly solved in the near future. When a more satisfactory biological unit is established it will be a simple matter to translate previous calculations into terms of that unit, provided accurate measurements and records of applicator doses are kept.

The accurate classification of a neoplasm must take place after careful consideration of several factors—the clinical course, the clinical setting and the gross and microscopic pathology. Since the advent of radiation therapy there has been added another factor, the comparative radiosensitivity. Radiosensitivity, however, cannot be estimated by comparing applicator doses except within very broad limits. However, if 100 cases of intraoral carcinoma which have regressed under, let us say, 8 S.E.D., could be compared under the microscope with 100 cases which had not regressed under 10 S.E.D., certainly it is reasonable to suppose that differences hitherto unrecognized would be discovered.

It should also be possible and advantageous to predetermine the required tissue dose in a specific neoplasm and then calculate what combination of applicators and applicator doses will be necessary to produce that tissue dose. We are at present following this method in selected cases. Unfortunately there is insufficient knowledge at present to estimate the necessary tissue dose required from the clinical setting and histology in the average case.

SUMMARY

The terms "applicator dose" and "tissue dose" are defined and their significance in radiation therapy is discussed. Curves for the depth doses of several applicators used at Memorial Hospital are shown and the methods of calculating the tissue doses from these applicators are explained.

Ten cases of neoplastic disease are reported in detail, giving the applicator doses and tissue doses in each with the end results.

CONCLUSIONS

It is possible to define the lethal radiation dose of a specific neoplasm within certain limits if careful measurements of the primary lesion and any metastases are made before treatment. Such calculations should be of great value both clinically and in the further classification of neoplastic diseases.*

* For discussion, see page 203.

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COMMENTS ON RADIUM TECHNIQUE*

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SEVERAL schools of radium technique, based upon theory, animal experimentation and large clinical observation, have developed in larger cancer institutions, and the independent radiotherapist, without opportunities for research and with much less experience, has, of necessity, generally acquainted himself with one technique or another which appealed to him and has followed it. That there are many good points about all the recognized techniques cannot be denied, but that there is room for considerable improvement in them must also be acknowledged.

There is, however, much difficulty connected with variation of technique, because it involves the keeping up of so many different sorts of apparatus, and, more important still, if radium element is used directly, the preparation and maintenance of so many different sizes and kinds of radium containers in permanent form. Thus an almost prohibitive amount of radium is necessary, as is also a very large staff to care for it and direct its use. Indeed, as Regaud urged at the International Conference on Cancer at Lake Mohonk in 1927, large cancer centers, institutions well endowed and equipped for treating cancer, should be established at convenient places throughout the country. It is only in such institutions where there is a large amount of radium available, that we can hope for the best technique and results. However, the private radiotherapist with general hospital facilities can and must help out for the present. But it is necessary that he devote much time to the study of the physics of radiation, as well as its chemical and biological action, and the physiology and pathology concerned in the disease he seeks to relieve. This is most difficult at present.

The literature on laboratory experimentation is enormous and very confusing. For instance, one group of well-known and reliable research workers finds by carefully planned and carried out experiments with grafted cancer, that irradiation of sound tissues, or of cancerous tissues, results in a certain amount of local or general immunity against cancer. This is worked out, confirmed or accepted by some of our best authorities, and techniques have been developed with the idea of producing immunity by indirect action of radiation, rather than by killing the cancer cell directly with the proper amount of radiation energy conveyed to it. Then Francis Carter Wood and his associates, and Regaud, Lacassagne and others, show that such results cannot be confirmed. Not only so, but they show that the interpretation of these experimental findings might just as well be for direct action of the irradiation on normal tissue, making the latter just as unreceptive to normal grafts as to the specific cancer graft. Indeed they have shown how very unreliable much of the irradiation work with grafted cancer is, because the study of controls with normal grafts has been neglected. And so the theory of the cure of cancer by indirect action of rays, long denied by Wood, or at least declared by him as far from proved, has now been practically discarded. However, this does not deny that there are local and general changes produced in the tissues and fluids of the body by irradiation which may be of benefit or injury to the patient in a local or general way, for this is abundantly proved. But such changes apparently have no specific action in relation to the immunity or the cure of cancer, though they probably do bear a relation to the cure of some infectious or metabolic diseases.

* Read at the Fourteenth Annual Meeting, American Radium Society, Portland, Oregon, July 8–9, 1929.

Again, while it is probably true that there is a specificity of action of the different wave lengths in the ultraviolet field, because they are too long to act intra-atomically, the notion that has long been prevalent among many radiotherapists that there is also a specificity of action of the individual wave lengths in the roentgen-ray and gamma fields, has also been proved to be erroneous. The roentgen and gamma rays of whatever frequency (except possibly the shortest highest gamma frequencies which cannot yet be studied) are all now known to have the same general action, but vary only in intensity and in penetration. It is simply a question of conveying the proper dose of radiation for absorption into the desired depth of tissue. All these shorter waves stimulate electronic reactions of greater or lesser intensity, which are considered responsible for the cellular changes observed. But cells vary greatly in their resistance, some requiring a much greater intensity of irradiation to dissociate their molecular architecture than others. Hence the selection of bundles of roentgen or gamma rays of whatever wave lengths for therapy is a matter first of all of choosing the ones which will reach the tissues it is desired to affect, and secondly, of getting the required rapidity of vibration or intensity of action, saving the normal tissues in the paths to be traversed by the rays, as much as possible, from their destructive action.

Upon these premises has been developed the techniques depending upon the theory of the direct action of rays. This is the theory of action of radiation which was held first, based no doubt upon Finsen's theory of the action of ultraviolet light, and which is now pretty generally accepted by the best authorities as the one upon which we must depend for the cure of cancer.

But the destruction of the tissue cell by direct action of radiation may be accomplished in two ways, just as was demonstrated by the great botanist, Carl von Naegeli, many years ago. He showed that more or less concentrated solutions of copper, for instance, would cause death of algae and Spirogyra by a sudden caustic destruction of their cells, while if these same organisms were put in infinitesimal solutions of mercury or other metals, or even in water in copper vessels, other chemical changes would take place, causing the gradual death of their cells without caustic destruction of the whole structure, but through destruction of the function of their cells. In a similar manner rapid vibrations of roentgen and gamma rays destroy cells by what Regaud and Lacassagne call either a "diffuse cytocaustic action" or an "elective cytolethal action."

The "diffuse cytocaustic action" happens if rays which do not penetrate very deeply are allowed to act for a sufficiently long time upon superficial tissues. The rays in this case strike indifferently and in the same degree all the constituent elements of the tissue, causing their immediate or later death. It is a caustic, necrotic action.

On the other hand, by the "elective cytolethal action" similar or even greater quantities of radiation filtered through metals of sufficient density and thickness, so that only the harder, more penetrating rays pass, produce no such results. Only certain kinds of cells in the tissues traversed by the rays, perhaps then only in certain stages of development, are seriously affected, while other cells in the immediate neighborhood, for one reason or another, are unaffected in any way so far as can be determined by the most precise methods of examination. These changes occur only in the more sensitive cells throughout the whole volume of the organ irradiated, in the deeper tissues, farthest away from the source of radiation, just as well as in the superficial tissues or those nearer the origin of the rays. Of course time is a most important factor here. If it is sufficiently prolonged, the intensity of action is greater and this "elective action" is changed into a caustic action, not only in the superficial

parts but throughout the depth of the tissues acted upon. But, again, as Regaud and Lacassagne say, "The elective action of radiations constitutes in them that characteristic property which serves to differentiate from the caustic and assures them of their superior value. It permits of that veritable dissociation of the different elements of the tissue which we have legitimately compared to a delicate cellular dissection, thanks to which radiations have taken rank as an important agent in physiological experimentation."

Perhaps the most successful technique of radiation therapy has been developed upon these principles.

Forssell and his associates, Berven[1] and Heyman[3] in 1912 and 1913 developed a technique which has given the highest rank to the work at Radiumhemmet in Stockholm. Here for sixteen years they have treated cancer by the most intense irradiation possible, using a filtration equivalent to 3 mm. of lead in cancer of the lip, cervix uteri, etc. Their practice in cancer of the cervix has been to use large quantities (about 70 to 80 mg.) of radium distributed in ten or twelve units in the vagina and about 38 to 43 mg. distributed in one to three units in the uterus, all this heavily filtered through 1.7 mm. lead and 0.45 mm. silver or through 0.35 mm. gold and 0.30 mm. platinum and permitted to act for about sixteen to twenty hours. A second somewhat similar application is made a week later and a third application two weeks after the second, thus giving about 2300 mg-ra-el. hours within the uterus and 4500 mg-ra-el. hours in the vagina.

Berven and Heyman[2] show in a period of five years from 1917–1922, 23 per cent cure in all cases of cancer of the cervix, and 40 per cent cure in cancer of the corpus. We understand, however, that some of the cancers of the body of the uterus were operated upon if satisfactory improvement did not take place from radium treatment in operable cases in two or three months. Roentgen rays as an adjuvant were used only in cases with metastases in the glands.

In the treatment of the lip and other regions the Swedish practice has been, till recently, to make surface applications of radium filtered through 3 mm. of lead. But in the last two or three years they have been using interstitial irradiation with implants of 10 mg-ra-el. needles composed of an inner layer of 0.35 mm. gold and an outer layer of 0.30 mm. platinum, which gives a filtration about equal to 1.1 mm. of lead, for two and a half to four hours. They apparently get no necrosis with this technique. Of late since they have more radium they are treating many deep-seated lesions like glands of the neck at a distance of 5 cm. through 3 mm. lead filter using units of 50 mg. at several entrance fields, the aggregate dose being 40–50 gm-hr. in a week or ten days.

Some of the early work done in this country, particularly that at Memorial Hospital in New York, was more of a cytocaustic character. First, interstitial irradiation by means of implantations of steel needles and later, in 1916, glass seeds introduced by Janeway produced severe radionecrosis of tissues in close proximity to the radiferous implants. This technique has been improved by the use of gold implants introduced by Failla in 1924. These have walls 0.2 to 0.3 mm. thick which screens out most of the caustic beta rays, but some beta rays and the longer gamma rays pass.

Quick[5] claims that by the use of these gold implants, the gamma-ray dosage is increased very appreciably, that the sloughing and hemorrhage of the former "bare tube" and glass radon technique no longer occur, that this technique embodies all the favorable features of the former technique and of Regaud's platinum needle method, and eliminates all the objectionable factors of both.

Regaud criticizes these implants as not permitting of sufficient filtration, 0.5 mm. of platinum being necessary to prevent radionecrosis. Inasmuch as concomitant

infection is so prejudicial against the cure of cancer by irradiation, as demonstrated by Regaud and others, it would seem that, by the introduction of implants, which would greatly increase the chances of this unfavorable accompaniment, the case might be influenced unfavorably. Then, too, by the interstitial method it is impossible always to insert the implants in a manner to reach all the growing edge of a cancer, since neither the clinician nor even the surgeon at operation can follow and locate the strings of cells that follow along muscle fibers, or along the sheaths of the vasculo-nervous system, often extending some distance from the primary growth. These most important cells can be reached only by external irradiation. Yet very favorable reports come from several large clinics, including Regaud's, from the use of gold or platinum needle implants, especially in cancer of the tongue. The use of radon instead of radium element comes into question because of the constant and rapid decrease of radiation, even though the total amount used may be as much or more than would be employed under similar circumstances with the element. This must be finally decided by the institutions which have large experience with both methods. The French school seems to prefer the use of the radium element even though this entails enormous expense in the original cost of radium and its maintenance in parcels of the desired quantities for so many and varied conditions.

By the implantation method, whether by platinum needles of radium element or gold seeds of radon, the most intense local irradiation may be produced, while metastatic tissues at a short distance may be neglected. Attempts to meet this and similar situations have been made with the combined use of roentgen rays with radium and this method of treatment is considered with favor in most clinics. Quimby has shown that about 20 per cent more radiation may be safely given with the combination than with one agent alone. Our personal clinical experience with radium and roentgen rays over several years would correspond with her experimental findings.

Now that more radium is available in such institutions as the Memorial Hospital in New York, the Radium Institute of the University of Paris and the Curie Foundation, and other institutions, deep therapy by radium at a distance in well-designed, protective apparatus, such as that recently built by Failla, is coming into use, and improvement in results with such technique may be expected.

Surface applications of radium packs heavily filtered, and at a distance of 0.5 to 5 cm., have been in use in several institutions following the classical demonstrations of Wickhan in 1912. They have served a most useful purpose and will no doubt continue to do so. This has been the principal technique used in Sweden and France.

Very early in radiation therapy differences in sensitivity of normal and diseased tissues were noted, and attempts to classify tumors according to their degree of sensitivity to irradiation were made. This was based upon the well-known law of Bergonié and Tribondeau in 1904 which recognized the fact that tumors composed largely of rapidly multiplying cells, especially of the embryonal and lymphoid types, were notably sensitive to radiation.

Upon the basis of radiosensitivity a new pathology is gradually becoming constructed, which, as Ewing says is much more complex and difficult but more serviceable. As a result of a comparative study of physiological and pathological sensitivity several new varieties of tumors have been discovered, such for instance as the highly radiosensitive lympho-epithelioma first described in 1921 by Regaud and Schminke. Broders' grading of the malignancy of epidermoid cancer, originally made without regard to radiosensitivity, corresponds closely with the degree of radiosusceptibility of this group of tumors, the most malignant grades being composed largely of anaplastic cells with frequent mitoses

which are, as a rule, the most easily destroyed by short-wave radiation. But there are many exceptions to the rule which we do not as yet understand. And so the query which still remains unanswered is, what is it in the cell that makes it radiosensitive or radioresistant?

Some cells are exceedingly resistant to roentgen and gamma radiation. Crowther found a certain species of Proteus very resistant, sometimes requiring as much as 100,000 R-units of roentgen rays to destroy it, and even then it would fully recover if the dose was divided, and three or four hours elapsed between the administration of the two parts of the dose.

The different cells of the same tumor, or, indeed, of the same normal tissue anywhere, vary a great deal in their sensitivity to irradiation. The degree of differentiation varies much in the cells, due perhaps to differences in ages of cells and in rapidity of multiplication. The higher the differentiation, the older the cell, and the less the frequency of division, the greater the resistance. If the diagnosis is made from a small section, such a section may be very far from the average cell constitution of the parent tumor, for Martzloff[4] in a study of 70 cases of biopsy sections, and later operated whole tumor specimens, found that in about one-third of all cases the biopsy material did not reflect the character of the parent growth. So, in irradiation of tumors, depending on biopsy diagnosis we may be misled as to grade of tumor almost once in every three cases, and the sensitivity of the tumor be less or more than we were led by biopsy to believe. The size of the biopsy section may modify this relation very much. This discrepancy in results of biopsies may account for some of the exceptions to the rule of sensitivity, since the tumor may not really belong in the grade the biopsy represented it.

Schmitz, Hueper and Arnold[6] have made a very detailed and complicated study of the "malignancy index" in carcinoma of the cervix uteri which is based on nine different cell characteristics, to which they have since added twelve others and to each they give numerical values.

This classification is a correlation from a composite picture of the malignancy of cervical carcinoma as considered in the maturity study of cells made by Martzloff, the grading of malignancy by Broders, and other important criteria described by Greenough.

Schmitz and Hueper's[7] technique of radium treatment of cervical cancer has never changed and consists in the intracervical insertion of two 25 mg. element capsules of radium placed in a filter of 0.5 mm. of silver and 1.5 mm. of brass. The applications are made in three weekly intervals of 30 to 32 hours' duration. Roentgen rays externally are used in conjunction. The technique of the roentgen-ray application has changed with the newer development of tubes and machines.

Schmitz reports groups of cases treated with these different improved roentgen-ray techniques and the same radium technique, over three periods, and shows that with the diminution of the wave length in roentgen-ray technique, the statistics in percentage of cures of all cases improved from 14.02 in the first period, 1914–1919, to 18.18 in the second period, 1020–1921, and 20.32 in the third period, 1922–1923. He ascribes the improved statistics to the use of short wave roentgen rays of 211 kv.

The French school under the directorship of Prof. Claude Regaud bases its technique upon the physiological study of the evolution of the cancer cell and its periods of relative radiosensitivity. At or about the period of mitosis it is most sensitive and gains resistance as it develops into the adult form. In order to attack all the cells during this sensitive period their irradiation is continued over a comparatively long time, about one or two weeks, depending upon the type and location of growth. In uterine cancer about 66.6 mg. of radium are used—about 33

mg. in the uterine canal and the balance distributed in the vagina in cork "colpostats" of about 2 cm. in diameter. The uterine radium is usually in three platinum tubes in 0.2 mm. of aluminum and placed tandem in a platinum capsule of 1 mm. wall thickness. The radium in the vagina is filtered through 1.5 mm. of platinum and kept by corks at a distance of about 1 cm. From two to three or four focal centers are used depending upon the size of the vagina, the extent of the growth, etc. Extreme care is taken to render the uterovaginal canal as clean as possible, a week or ten days being spent on this before beginning radium treatment. Scrupulous care is taken to sterilize the apparatus, it being removed and sterilized each day. A total gamma irradiation of about 5000 to 8000 mg-hr., figured in millicuries-destroyed, is given. Deep roentgen therapy, or recently, radium treatment is given in addition externally in cases showing infiltration about the uterus. The length of time for the application is on the average about 100 hours.

With this technique Regaud shows statistics of five to six year cures of 26.7 per cent of all cases treated, which is a marked improvement over statistics in other clinics.

The technique used in the skin and other regions is somewhat similar, depending upon the same principles, the toleration of the surface exposed, the amount of radiation necessary per square centimeter of tissue being carefully figured out. In the skin, for instance, from 2 to 4 millicuries-destroyed per sq. cm. are administered, depending upon the nature of the tumor and the area to be treated. The filtration is through 1 or 2 mm. of platinum and a moulage of wax and sawdust 0.5 to 3 cm. thick, depending upon the depth dose required. The time extends over a period of a week or ten days.

Theoretically and practically it would seem that the technique being carried out by the French school is superior to all other techniques now in use for the following reasons:

1. The length of time of irradiation is long enough to permit of attack on cancer cells during the period of their cycle of renovation when, according to present knowledge, they have the lowest resistance.

2. The high filtration permitting the passage of only very hard, more homogeneous gamma rays, also protects neighboring sound cells from the caustic action which would follow a too intense irradiation with rays of less homogeneity and penetration. The more homogeneous the irradiation, the greater safety to the sound intervening tissues, and the greater can be the accuracy of the computation of the dosage.

3. The distribution of highly filtered radium over focal areas of size and distance calculated to give the most even distribution of the irradiation deep in the tissues, spares the normal physiological cells from necrosis and late serious consequences, while dealing out fatal amounts of energy to the weakened pathological cells.

4. Statistics of cures of different types of cancer by techniques based upon some of these theories and experimental evidence compare very favorably with statistics from other clinics.

It is questionable if radionecrosis is ever desirable or justifiable in radium therapy. If we desire to destroy all tissues, normal and pathological, in a certain area, would it not be better to use some other form of caustic which is less painful in its results, quicker in healing, and thus accomplish as much or more good for the patient? Such caustics as electrocoagulation, the cautery knife, or even the actual cautery or some other chemicals might be used to as good advantage, saving the radium for its lethal action on diseased cells. Certainly such serious accidents as rectovaginal and vesicovaginal fistulas can be avoided and the best results be accom-

plished by proper distribution and filtration of radium within the vagina and uterus, increasing the time factor and using deep roentgen therapy over the pelvis in conjunction. Similar radionecrotic destructions of normal skin, muscle and bone, involving vessels of various sizes, important nerves, etc., are not always so serious, but sometimes are, and, in any case, they destroy function. One accomplishes no more, or perhaps not as much by this method, than by the more elective action of hard gamma rays on diseased cells, without seriously injuring normal tissues.

If we would have greatest success with radium, we must not only utilize our knowledge of the physics of the element but also study carefully and make application of its physiological and chemical action, and reserve for surgery or other agents any destructive action that may seem necessary.

We must also study the cellular pathology concerned, especially in relation to degree of malignancy and radiosensitivity, and then select the technique most applicable in each individual case.

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ABSTRACT OF DISCUSSION ON PAPERS OF QUIMBY,* SANTE,* MARTIN AND QUIMBY, AND STEVENS

Dr. George E. Pfahler, Philadelphia. We are indebted to Mrs. Quimby for working out the tables which will surely be useful to us in calculating our dosage. They will not be immediately valuable unless we use the same equipment she is using, but ultimately I am hopeful that these tables will be of value in determining the special dosage with radium element which is used by most of us. The butter test is of value in their work, but in working with the human being we have many other factors and influences to take into consideration. We must combine our clinical sense with the data in the table.

Dr. Sante well illustrated the variations in tissue sensitivity. I think we are a long way from estimating that sensitivity by the microscope. Those carcinomas of the face that produce ulceration and no overgrowth of tissue are, in my experience, the most difficult to overcome. If any one will tell me how to treat the rodent ulcer, which is basal cell in type, and the basal cell cancer is considered easy to cure, if anyone can tell me how to cure a rodent ulcer that has infiltrated into the ethmoid cells, involving the mucous membrane and the bone, or has gone into the mastoid cells, I shall be glad to listen. I do not mean that we do not cure some of them, but in most of them we fail. We may cure them for a year or two and then they start to grow again. These extensive growths belong to the group we class as the rodent ulcers, but I think the whole secret of success is to *get them before they have invaded the deeper tissues.* I believe that in dealing with the ulcerative type of basal cell carcinomas it is best to destroy the growth right at the beginning by any method we can, and then to apply the radiation highly filtered in order to reach any cells that may have been missed.

* Papers by Quimby and Sante were published in the January number of the Journal.

This whole group of papers illustrates the tremendous difficulties we have to deal with in handling radiation and it must be much greater if a man simply buys a little radium and takes instruction from the salesman as to how to treat cancer. It is easy to understand how many such men lose faith in radium as a means of treating cancer. We have heard of the great difficulties experienced by some of the best radiologists in the country, and if they have so much difficulty you can understand how much greater will be the difficulty of men who have *not studied the matter* as these authors have.

Mrs. Quimby illustrated another fact in the second paper she read; namely, that enormous amounts of radiation must be utilized. My principle up to the present time, because of these great difficulties, has been to give *all the irradiation that the normal tissues will stand* on the basis of the "saturation method," and we can increase the amount of irradiation that the normal tissues will stand by lengthening the dose and by increasing the filtration. Increase the filtration, whether you do it with gamma rays or with roentgen rays does not matter, except that you can use so much more filtration with the gamma rays. The fact that you reach, in this way, the cancer cell which is in the dividing stage, and the fact that the normal tissues will stand much more irradiation is important. The tissues about the face will stand from 5 to 8 erythema doses over small areas, if given over a long period of time, but if given all at once there is absolute destruction. That is probably the chief advantage of the "saturation method," giving all that can be safely administered at first and then prolonging treatment over three or four weeks.

DR. G. W. GRIER, Pittsburgh, Pa. I remember how discouraged I felt when Dr. Wood reported his experiences with the treatment of mouse cancer about ten years ago, and showed that it took ten times an erythema dose to destroy those cancer cells. Most of us who had been treating cancer, I am sure, felt that it was impossible ever to apply such a dose and cure patients. I am very grateful to the speakers this morning for the reports that cancer has been cured by such dosage. I have been feeling for years that it required ten times an erythema dose to cure some cancers. I have been using such a dose as was described for fifteen years in the treatment of superficial cancer and am delighted to hear that Dr. Martin and Mrs. Quimby have proved that such a dose will cure deep-seated lesions. These papers open up a new line of thought. Possibly most of our failures have been due to under-dosage.

Mrs. Quimby's paper rather emphasized the very important fact that some methods of applying radium will give better results than others, or that one method will produce results that another will not.

Dr. Sante's remarks are proof that the radiosensitivity of tumors cannot be estimated. For that reason I have treated all tumors as if they were of the most resistant type. I believe that this is the only safe method. I do not agree with Dr. Sante that it is well to treat with a milder dose and see if the tumor will respond, and then give a full dose if necessary. I think we will in the long run do less damage if we give the full dose at first.

As Dr. Stevens remarked, there are many things that can be read between the lines. Certainly Regaud's method is a large dose method, for although he uses small amounts he leaves them in for a long time. There is the small amount of radium acting over a long period, which is much less apt to harm normal tissues, and the favorable effect on the cancer probably comes from the large dosage.

DR. D. T. QUIGLEY, Omaha, Nebr. That matter of dosage should be our most earnest consideration. In our experience, extending over fifteen years, we have adopted in our work what we call a "knock-out dose." If we used a dose that was not sufficient to destroy a basal cell cancer of the face, or, in other words, a dose that was too small, and then added another, and then found that was not enough and, then added still more, we found a decreasing sensitiveness of tumor cells with each experience. In other words, we found that each time we gave a dose insufficient to kill the cancer cells, the cells themselves built up a resistance to irradiation, and finally some epitheliomas developed more resistance against irradiation than normal cells.

If we are treating a growth such as in the cervix and are near any organ that may be broken into, such as the rectum or bladder, we use a smaller dose for we have a very wholesome respect for those organs, but in the breast or other external cancers, we go ahead and treat as extensively as we think is necessary.

In many breast cases we irradiate the bone sufficiently to cause necrosis of the ribs, but subsequently these heal.

Mrs. Quimby (closing). With regard to the dosage information for needles containing more than 1 mg. of radium, we are going on with that work, and I hope to be able to present the results before long.

There is one point I wish to bring out in regard to Dr. Pfahler's saturation technique. He states that with this method of treatment the skin of the face will stand from 5 to 6 erythema doses, as opposed to a maximum of 2 or 3 with the method discussed in our paper. May it not also be true that with the saturation method the cancer will stand considerably more irradiation? In other words, in increasing the skin tolerance, is it not possible that the cancer tolerance has also been increased? It seems to me that this is a very important point, and one which should be investigated experimentally very soon.

The use of the "knock-out dose" is an admission that we do not know how much irradiation is actually necessary to control a growth. Without this knowledge it is, of course, wise to push treatment to the limit of tolerance. The purpose of such work as I have reported today is to discover the approximate dosage needed in different types of malignant disease. When we can state definitely that one type requires a certain minimum amount of irradiation, and another type a different amount, there will be no reason for subjecting a radiosensitive lesion to such drastic treatment as a radioresistant one.

The case we reported as receiving 22 erythema doses should not be considered as typical. No radiation therapist would accept this amount as a desirable dose to adopt as a standard. This was a very small lesion, in which a few millicuries delivered a large dose. Such a case shows that comparatively large quantities of radiation can be used in small lesions without causing trouble. But it is to the cases that have done well with from 8 to 10 erythema doses that we particularly desire to call attention.

Dr. Sante (closing). I fear I have created a false impression. I did not mean we should treat every tumor with a small dose and then follow with a large one if necessary. My statement referred only to tumors of doubtful character. I said we should never consider any growth, no matter how small, as insignificant, or any growth, no matter how large, as hopeless until it had been given the "test of irradiation." I defined the "test of irradiation" as one full course within the tolerance dose of radiation.

SUPERNUMERARY DISTAL PHALANX OF THE THUMB

CASE REPORT

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IN 1920 Reeves[4] found after a most thorough search through the literature that only few cases of supernumerary digits had been reported. His was the first case which presented no familial nor ancestral existence of this anomaly. The patient had two separate nails about the size of that of his normal little finger, with a slight web between them. The illustrations of the thumb of his case show terminal phalanges which articulate with the first phalanx of the right thumb on either side of the distal end of that phalanx. One of these does not seem to be a normal single phalanx but presents the appearance of a very close fusion of two separate bones near its distal portion.[4]

In Reeves' account of the other cases reported in the literature[1,2,3,5] there is an indication that in practically all of the anomalies heretofore described, there were present, in addition to two nails and more than one distal phalanx, double metacarpal bones or a supernumerary digit,[6] on the radial side of the metacarpal bone, provided with a well-formed nail and consisting of two phalanges.

In January, 1929, H. S., a plumber, twenty-three years of age, came to my office complaining of a urethral discharge. Upon examination of the penis I found the glans to be about half the normal size. An artificial meatus was situated midway between the tip and the base of the penis. The patient explained that he was not able to urinate after birth, and a local surgeon had operated upon him and had made the artificial opening. Examination of the discharge revealed the presence of a Neisserian infection for which he had to be treated cautiously, due to the peculiar structure of the penis. The tip of the penis presented no opening, the rudimentary glans having an uninterrupted surface and being centrally situated over the location of normal meatus.

Upon my inquiry as to any other anomalies he might have, the patient showed his left thumb which presented two nails of equal size situated upon distal phalanges which were proximally directed towards a common base, the distal portion of the proximal phalanx of that thumb. The nails and phalanges were smaller than those of his other thumb. Both the phalanges were joined by a web. Flexion was present for both to 45°. A slight peculiar adductive function was present so that the patient was able to make both the distal phalanges incompletely face each other. This suggested the possibility of the presence of a distal interphalangeal articulation. A roentgenogram was taken of the thumb (Fig. 1).

FIG. 1.

This shows clearly the presence of a triple joint consisting of the meeting places of articulating surfaces between the proximal ends of the distal phalanges, and also between the distal portion of the proximal phalanx of that thumb and the bases of the proximal ends of both the distal thumbs. The three bones meet and form a triple joint. So far as I know, such a condition has not been heretofore described in the literature. Neither do the

figures presented by other writers who report the presence of supernumerary phalanges, point to the existence of such an anomaly as the above case. Sensation and functioning power of the thumb are both normal except for the impairment in flexion. The patient is left handed. There is no history of the presence, either in his family or in his ancestry, of such or similar conditions.

SUMMARY

A case showing a supernumerary distal phalanx of the left thumb is presented.

A triple distal interphalangeal partially functioning articulation is shown in this anomaly.

An anomaly of the penis is also present in this patient.

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INJURY TO EPIPHYSIS OF LOWER END OF ULNA AND RESULTING DEFORMITY

CASE REPORT

By EDGAR BIRDSALL, M.D.

GLENS FALLS, NEW YORK

A boy, aged fifteen, was referred to us for a roentgen examination of his left elbow and forearm because of a slowly developing bowing of the forearm and an inability to completely extend the elbow joint.

Fig. 1.

Five years previously he had sustained an injury to his left wrist joint. A roentgen examination was made by a dentist and reported negative.

The present roentgen examination shows that the head of the ulna, epiphysis and lower end of the diaphysis are missing and that the radius is bowed with the head pushed well up into the elbow joint (Fig. 1).

Impression. There has been a fracture of the ulna in the region of the epiphysis, followed by absorption of the head and diaphysis which resulted in an arrest of development of the lower end of the ulna. The radius continued to develop, hence the deformity seen in the films.

This is another evidence of the seriousness of injuries in the region of the epiphyses and the necessity for their early recognition.

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THE AMERICAN JOURNAL OF ROENTGENOLOGY AND RADIUM THERAPY

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EDITORIAL

POSTOPERATIVE ABSCESS OF THE LUNG

THE past four years have seen a remarkable number of careful and thorough studies concerning the etiology of abscess of the lung. Heretofore papers dealing with this subject have been mostly clinical reports and these have largely emanated from the field of laryngology. Now we find surgeons, pathologists, internists, roentgenologists and many specialists, reporting their studies and opinions. The great stimulus for all this seems to lie in part in our better methods of detecting pulmonary lesions by means of the roentgen ray; in part to the general wave of opinion which has called forth the many excellent end-result studies and which in this field alone has doubtless recalled to many an operator one of the late dangers of his art, and in part to investigations dealing with the general and serious question of the etiology of the many serious postoperative pulmonary sequelae of which abscess of the lung is one of the less frequent.

It is obvious from a survey of the great mass of publications that the important differences of opinion concern the question: Is the infective matter aspirated or carried to the lung by the blood stream? The quarrel between the protagonists of aspiration and embolism is an old one. It began to be serious when local anesthesia first came into general use and particularly in 1900 when Mikulicz published his studies on postoperative pulmonary complications and demonstrated that patients under local anesthesia had the same pulmonary complications, both as to type and percentage, as when general inhalation anesthesia was used. He proposed embolism as the source of the pulmonary lesions when local anesthesia was used and since that time careful studies have demonstrated that some cases of postoperative pulmonary complications are embolic in origin.

The immediate problem of postoperative abscess of the lung has given rise to the same arguments that have surrounded the larger problem of postoperative pulmonary complications for forty years. Proponents of the aspiration theory cite the open pathway, the obvious possibility of mouth organisms reaching the lung through this pathway, the occurrence of aspiration of buccal contents even with local anesthesia in operations within the mouth, the fact that mouth organisms are frequently found in these abscesses and that the operation of tonsillectomy is the chief source of this dilemma. Moreover, investigations have shown that by aspiration abscess may result. It is true that in the experiments of Crowe an operation was performed on the frontal sinuses, that in the experiments of Smith the bacteria were injected across the trachea, and that in all other successful aspiratory investigations the bacteria were effectively blocked by the use of foreign bodies to plug the bronchus.

Proponents of the embolic theory have long demonstrated and again shown that the aspiration of buccal contents is a normal mechanism and that it occurs equally in those who do not, as well as those who do, develop abscess of the lung. They have demonstrated that in proportion to the number of operations abscess follows tonsillectomy no more frequently than it does operations in any other infected or potentially infected field. They have pointed out that in their hands, as in others, the aspiration of bacteria in amount and quality similar to what might occur in man does not yield abscess; they have with jus-

tice claimed that to inject bacteria across the trachea is not the same as aspiration and they have finally and impressively demonstrated that abscess of the lung results far more readily by the use of infected emboli than by aspiration even in the hands of its most ardent proponents. Also their studies of susceptibility and immunity in relation to spreading or localization of an infection which may reach the lung via the blood stream throws an important light on the whole question.

More recently matters of bacteriology and the question of a specific responsible organism have been agitated. In part, this controversy which revolves about the rôle of the Vincent spirochetes and fusiform bacilli is mistaken, and undoubtedly certain investigators are confusing gangrene and abscess of the lung. Others, at a period in science when the older bacteriology of specific organism for each disease is disappearing, seem to be hold-overs from a by-gone era. It is common clinical knowledge that arsenical drugs improve but do not cure cases of abscess of the lung. The spirochetes and fusiform bacilli are anaerobes and only under special conditions very pathogenic. It seems assured that in abscess of the lung they are secondary contaminators.

The proponents of the embolic school have attempted to explain the presence of these organisms by showing that alone they may not incite abscess, but that in association with other organisms they constitute the factor that makes the abscess chronic. Furthermore, careful studies on clinical cases have shown that acute abscess of the lung occurs and heals. In such cases where the lesions are recognized early and arsphenamine treatment at once instituted these abscesses, originally parenchymatous and not connected with the bronchial tree, never become infected with the various anaerobic organisms and therefore never become chronic.

It is obvious that the problem is not yet completely solved. Doubtless both aspiration and embolism play a dominant rôle in selected cases. The experimental evidence is a little more in favor of the embolic method. Also in the broader relation to the whole field of postoperative pulmonary complications it is certain that embolism is unquestionably a dominant factor in many cases. Possibly it would be wise for all the investigators in this field to realize this larger application of their work and become entirely familiar with its background. After all, postoperative abscess of the lung doubtless has much in common with the so-called postoperative pneumonia, postoperative pleurisy, and postoperative pulmonary embolism. It may indeed be merely a matter of local or general immunity which in one case dictates abscess and in the next pneumonitis.

Elliott C. Cutler

SOCIETY PROCEEDINGS, CORRESPONDENCE AND NEWS ITEMS

Items for this section solicited promptly after the events to which they refer.

MEETINGS OF ROENTGEN SOCIETIES*

UNITED STATES OF AMERICA

AMERICAN ROENTGEN RAY SOCIETY
Secretary, Dr. John T. Murphy, 421 Michigan St., Toledo, Ohio.
Thirty-first annual meeting: West Baden, Indiana, Sept. 23–26, 1930.

AMERICAN COLLEGE OF RADIOLOGY
Secretary, Dr. Albert Soiland, 1407 S. Hope St., Los Angeles, Calif.
Annual Meeting, Detroit, Mich., 1930.

SECTION ON RADIOLOGY, AMERICAN MEDICAL ASSOCIATION
Secretary, Dr. G. W. Grier, Jenkins Arcade, Pittsburgh, Pa.
Annual meeting, Detroit, Mich., June 23–27, 1930.

RADIOLOGICAL SOCIETY OF NORTH AMERICA
Secretary, Dr. I. S. Trostler, 812 Marshall Field Annex, Chicago, Ill.
Sixteenth annual session: 1930, to be announced.

RADIOLOGICAL SECTION, LOS ANGELES COUNTY MEDICAL SOCIETY
Secretary, Dr. Lowell S. Goin, Wilshire Medical Building, Los Angeles.
Meets on the third Wednesday of each month at the California Hospital.

RADIOLOGICAL SECTION, SOUTHERN MEDICAL ASSOCIATION
Secretary, Dr. W. S. Lawrence, Medical Arts Bldg., Memphis, Tenn.

BUFFALO RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. Joseph S. Gian-Franceschi, 610 Niagara St.
Meets second Monday of each month except during the summer months, the place of meeting to be selected by the host.

CHICAGO ROENTGEN SOCIETY
Secretary, Dr. W. T. Bronson, Englewood Hospital.
Meets monthly on second Thursday from October to May (except during month of December) at Virginia Hotel. Dinner at 6 P.M., scientific session at 8 P.M.

CLEVELAND RADIOLOGICAL SOCIETY
Secretary, Dr. Harry L. Farmer, 2930 Prospect Ave.
Meetings are held at 6 o'clock at the University Club on the fourth Monday evening of each month from September to April, inclusive.

DETROIT ROENTGEN RAY AND RADIUM SOCIETY
Secretary, Dr. O. J. Shore, Fisher Building.
Meets monthly on first Thursday from October to May, at Wayne County Medical Society Building.

CENTRAL ILLINOIS RADIOLOGICAL SOCIETY
Secretary, Dr. H. C. Kariher, Decatur, Illinois.
Regular meetings held quarterly.

INDIANA ROENTGEN SOCIETY
Secretary, Dr. J. N. Collins, Indianapolis, Ind.
Annual meeting each February 22 in Indianapolis.

MILWAUKEE ROENTGEN RAY SOCIETY
Secretary, Dr. J. E. Habbe, 221 Wisconsin Ave., Milwaukee.
Meets first Friday in October, December, February and April.
Place of meeting designated by the president.

NEW ENGLAND ROENTGEN RAY SOCIETY
Secretary, Dr. Thomas R. Healy, 370 Marlboro St., Boston, Mass.
Meets monthly on third Friday, Boston Medical Library.

NEW YORK ROENTGEN SOCIETY
Secretary, Dr. Robert E. Pound, Fifth Avenue Hospital.
Meets monthly on third Monday, New York Academy of Medicine.

CENTRAL NEW YORK ROENTGEN RAY SOCIETY
Secretary, Dr. D. S. Childs, 316 Gurney Bldg., Syracuse, N. Y. Three meetings a year—April, August and November.

PACIFIC COAST ROENTGEN RAY SOCIETY
Secretary, Dr. Harold B. Thompson, Seattle, Wash.
Two meetings a year.

PENNSYLVANIA RADIOLOGICAL SOCIETY
Secretary, Dr. W. E. Reiley, Clearfield, Penna.
Two meetings a year, April and October.

PHILADELPHIA ROENTGEN RAY SOCIETY
Secretary Dr. John T. Farrell, Jr., 235 S. 15th St., Philadelphia.
Meets monthly on first Thursday evening, Pennsylvania Hospital.

* Secretaries of societies not here listed are requested to send the necessary information to the Editor.

ROCHESTER ROENTGEN RAY SOCIETY, ROCHESTER, N. Y.
Secretary, Dr. James M. Flynn, 282 Alexander St.
Meets monthly on the first Friday evening at 7:45 at the Rochester Medical Association Building.

ST. LOUIS ROENTGEN CLUB
Secretary-Treasurer, Dr. L. R. Sante, Missouri Building
Meets first week of each month. Time and place of meetings designated by president.

TEXAS RADIOLOGICAL SOCIETY
Secretary-Treasurer, Dr. C. P. Harris, Houston, Texas.
Meets annually one day preceding the meeting of the Texas State Medical Association.

UNIVERSITY OF MICHIGAN ROENTGEN RAY SOCIETY
Secretary, Dr. D. M. Clark, University Hospital, Ann Arbor, Mich.
Meets every Wednesday evening from September to July, at 7:30 o'clock in the amphitheatre of the University Hospital.

VIRGINIA ROENTGEN RAY CLUB
Secretary, Dr. Wright Clarkson, 205 S. Sycamore St., Petersburg, Va.

British Empire

BRITISH INSTITUTE OF RADIOLOGY INCORPORATED WITH THE RÖNTGEN SOCIETY
Director, Dr. John Muir, 32 Welbeck St., London W. 1.
Meets on the third Thursday of each month, from November to June inclusive, at 8:15 P.M., at 32 Welbeck St., London, W. 1., or as advertised.

ELECTRO-THERAPEUTIC SECTION OF THE ROYAL SOCIETY OF MEDICINE (CONFINED TO MEDICAL MEMBERS)
Meets on the third Friday of each month during the winter at 8:30 P.M. at the Royal Society of Medicine, 1 Wimpole St., London, W. 1.

SECTION OF RADIOLOGY AND MEDICAL ELECTRICITY, AUSTRALASIAN MEDICAL CONGRESS
Secretary, Dr. H. M. Cutler, 139 Macquarie St., Sydney, New South Wales.

RADIOLOGICAL SECTION OF THE VICTORIAN BRANCH OF THE BRITISH MEDICAL ASSOCIATION
Secretary, Dr. Colin Macdonald, Lister House, 61 Collins St., Melbourne, Australia.
Meets monthly at Melbourne during the winter.

SECTION ON RADIOLOGY, CANADIAN MEDICAL ASSOCIATION
Secretary, Dr. A. H. Rolph, 160 St. George St., Toronto, Ont.

RADIOLOGICAL SECTION, NEW ZEALAND BRITISH MEDICAL ASSOCIATION
Secretary, Dr. P. C. Fenwick, The Hospital, Christ-church.
Meets annually.

Continental Europe

BELGIAN SOCIETY OF ROENTGENOLOGY
Secretary, Dr. J. Boine, Avenue des Alliés, 134, Louvain (Belgium).
Meets monthly on second Sunday at d'Egmonds Palace, Brussels, except in the summertime.

SOCIETE DE RADIOLOGIE MÉDICALE DE FRANCE
Meets monthly on second Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

SOCIÉTÉ SUISSE DE RADIOLOGIE (SCHWEIZERISCHE RÖNTGEN-GESELLSCHAFT)
Secretary for French language, Dr. A. Grosjean, La Chaux de Fonds.
Secretary for German language, Dr. Scheurer, Molzgasse, Biel.
Meets annually in different cities.

SOCIÉTÉ FRANCAISE D'ELECTROTHÉRAPIE ET DE RADIOLOGIE MÉDICALE
Meets monthly on fourth Tuesday, except during months of August and September, 12 Rue de Seine, Paris.

ASSOCIATION OF GERMAN ROENTGENOLOGISTS AND RADIOLOGISTS IN CZECHO-SLOVAKIA
Secretary, Dr. Walter Altschul, German University, Prague, II/52.

DEUTSCHE RÖNTGEN-GESELLSCHAFT (GE SELLSCHAFT FÜR RONTGENKUNDE UND STRAHLENFORSCHUNG)
Meets annually in April, alternating one year in Berlin, one year in some other German city. Meets in addition every two years with the Gesellschaft deutscher Naturforscher und Aerzte.
Permanent secretary, Professor Dr. Haenisch, Klopstockstrasse 10, Hamburg, Germany.

SUD- UND WESTDEUTSCHE RÖNTGENGESELLSCHAFT
Meets annually in different cities.

NORD- UND OSTDEUTSCHE RÖENTGENGESELLSCHAFT
Meets annually in different cities.

DUTCH SOCIETY OF ELECTROLOGY AND ROENTGENOLOGY
Holds two meetings a year in Amsterdam, one in the Spring, and one in the Fall.

SOCIETA ITALIANA RADIOLOGIA MEDICA
Secretary, Professor M. Ponzio, University of Turin, Turin.

SOCIETATEA ROMANA DE RADIOLOGIE SI ELECTROLOGIE
Secretary, Dr. Nicolae Busila, 44 Elizabeta Blvd., Bucarest.
Meets second Monday in every month with the exception of July and August.

ALL-RUSSIAN ROENTGEN RAY ASSOCIATION, LENINGRAD, USSR in the State Institute of Roentgenology and Radiology, 6 Roentgen St.
Secretaries, Drs. S. A. Reinberg and S. G. Simonson.
Meets annually.

LENINGRAD ROENTGEN RAY SOCIETY
Secretaries, Drs. S. G. Simonson and G. A. Gusterin.
Meets monthly on the first Monday at 8 o'clock in the State Institute of Roentgenology and Radiology, Leningrad.

MOSCOW ROENTGEN RAY SOCIETY
Secretaries, Drs. L. L. Holst, A. W. Ssamygin and S. T. Konobejevsky.
Meets monthly on the first Monday at 8 o'clock, the place of meeting being selected by the Society.

POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. A. Elektorowicz, 19 Hoza St., Warsaw.
Meets annually.

WARSAW SECTION, POLISH SOCIETY OF RADIOLOGY
Secretary, Dr. B. Krynski, 11 Zielna St.
Meets once a month except in the summertime.

SCANDINAVIAN ROENTGEN SOCIETIES
The Scandinavian roentgen societies have formed a joint association called the Northern Association for Medical Radiology, meeting every second year in the different countries belonging to the Association. Each of the following societies, with the exception of the Denmark Society, meets every second month except in the summertime:

SOCIETY OF MEDICAL RADIOLOGY OF SWEDEN
Meets in Stockholm.

SOCIETY OF MEDICAL RADIOLOGY IN NORWAY
Meets in Oslo.

SOCIETY OF MEDICAL RADIOLOGY IN DENMARK
Secretary, Dr. O. Wissing, Copenhagen.
Meets on the second Wednesday of each month from October to July in Copenhagen, at 8 o'clock in the State Institute of Roentgenology.

SOCIETY OF MEDICAL RADIOLOGY IN FINLAND
Meets in Helsingfors.

VIENNA SOCIETY OF ROENTGENOLOGY
Secretary, Professor Holzknecht, Vienna, IX, General Hospital.
Meets on the first Tuesday of each month from October to July.

VIENNA LETTER

(*From our Special Correspondent*)

THE ACTION OF ROENTGEN RAYS IN ACCELERATING THE CLOTTING OF BLOOD

Dr. Horvath, of Hungary, uses roentgen-ray treatments in cases of obstinate menorrhagia and metrorrhagia and in other cases of obstinate hemorrhage. The treatment consists in irradiating the spleen. This tends to accelerate the clotting of the blood whereby obstinate hemorrhages are often stopped. His technique is as follows: In the cases where the spleen is of normal size and normal position the patient is laid on the right side, the left arm is raised high above the head and by percussion the actual size of the spleen is made out. The roentgen rays are applied to the area corresponding to the splenic dullness over a field about 20×15 cm. The focus skin distance is 30 cm., the other factors being, 30 kv., 8 ma., with 5 mm. Al filter. The quantity of rays applied to the skin amounts to 25 per cent of the tolerance dose. The treatment is repeated after a lapse of four weeks and if this does not prove sufficient another treatment is administered after three weeks. No more than three or four irradiations are necessary.

HOW THE MEASUREMENT OF THE WAVE LENGTH OF ROENTGEN RAYS WAS DISCOVERED

In a recent article in a Vienna medical journal, upon the occasion of the celebration of the birthday of Max Laue, professor of physics and winner of the Nobel prize, is described how Professor Laue discovered the way of measuring the wave length of roentgen rays. If one takes a glass plate and scratches innumerable parallel lines upon it, the sun's rays passing through this grid become dissolved into rainbow colored stripes. The fine lines on the glass plate act as prisms. Now if one places another such grid upon it transversely so that the grid systems cross each

other, then we have to deal not only with a dash but with a dot grid (Punktgitter). If the light rays pass through this grid then patterns are formed from which the wave length of the light may be reckoned. Some of the early researchers tried to determine the wave length of the roentgen rays with the aid of the dot grid but this was impractical because the distance between the parallel lines, though being extraordinarily small (about the fraction of a thousandth of a millimeter) was still enormously large as compared with the roentgen rays. Then came the happy discovery of Laue. He conceived the idea that nature itself created the finest and most perfect dot grid. Every crystal represents such a dot grid because in a crystal molecules and atoms are arranged according to certain patterns. A crystal is an astonishingly regular set of molecules (or dots). As these molecules are quite compact Laue thought he might find in them the ideal dot grid for which physicists had hunted in vain. With his two assistants, Knipping and Friedrich, he began to carry on experiments. He forced a bundle of roentgen rays through corundum crystals to have them fall after their exit on a photographic plate. As Laue describes it he was quite excited during the time that the photographic plate was being developed. The development of the plate proved positively that Laue's assumption was correct. The atom dots were actually so close to each other that the roentgen rays were subjected to the same deflection or bending as were the common light rays passing through the dot grid. The photographic plate displayed a system of dots as wonderfully and regularly arranged as in a kaleidoscope. Now the wave length of roentgen rays could be actually measured. Investigators had to take recourse to the ultramicroscopical domain where fractions of a millionth of a millimeter can be reckoned by suitable competent methods. Their experiments also revealed that only 230 groups of such dot systems exist and that all the crystals of the world may be classified into these possible 230 groups.

AN IMPORTANT CHOLECYSTOGRAPHIC SIGN NOT HITHERTO APPRECIATED

Dr. Blond, of Germany, observed that twelve hours subsequent to the intravenous injection of contrast material deposits of the same are seen not only in the shadow of the gall-bladder but also in the colon and at the level of the hepatic flexure. Blond attributes to this observation important conclusions: (1) Contrary to what we had thought, the liver voids bile mixed with the contrast material into the intestine during the fasting period and therefore the hypothesis of an antagonism between the musculature of the gall-bladder and the sphincter of Oddi is untenable, for while during the fasting period the evacuation of the gall-bladder cannot be demonstrated, it is evident that contrast material is voided through the papilla of Vater. (2) The deposit of contrast material in the intestine is the visible sign on the roentgenogram of liver function. (3) Normal gall-bladder shadows and normal intestinal deposits of the dye both confirm the patency of the papilla of Vater (the presence of a stone or scarring in the common duct may be excluded). (4) A faint gall-bladder shadow and a large deposit of the contrast material in the colon points either to a decreased absorbing power of the mucous membrane of the gall-bladder or to a constriction of the Heister valve. If there is no gall-bladder shadow and there is presence of a deposit of the contrast material in the intestine, this is a definite sign of the patency of the common duct and of the papilla of Vater.

ROENTGEN CONSIDERATION OF THE TEMPOROMANDIBULAR JOINT

To the Editor:

Bishop, in the June, 1929, number of the American Journal of Roentgenology and Radium Therapy draws attention to

the temporomandibular joint, especially as seen in the lateral view of the skull. No doubt this article will stimulate considerable interest in the study of this joint. Although passing reference has been made to the posteroanterior view of the skull, no mention whatever has been made of the view from the frontoparietal region obliquely downwards to the base of the skull, with the chin stretched forward as far as possible. I have described this position as the "gargoyle" position in the *Medical Journal of Australia* for December 12, 1925.

This not only shows the joints of both sides, but shows the glenoid fossa between the anterior and posterior roots of the zygomatic process. The articular eminence in front is readily seen, while the relation of the condyle is clearly and definitely shown. In addition to the neck, the coronoid process and rami are displayed. Incidentally, the "gargoyle" position shows many other features of the base of the skull.

H. FLECKER

Melbourne, Australia,
October 21, 1929.

Vol. XXIII, No. 2

DEPARTMENT OF TECHNIQUE

Department Editor: David R. Bowen, M.D., Pennsylvania Hospital, Philadelphia, Pa.

A SIMPLIFIED HAND STEREOSCOPE

By LEE A. HADLEY, M.D.

SYRACUSE, NEW YORK

In the American Journal of Roentgenology, December, 1918, was published the description of a hand stereoscope designed by Caldwell[1] probably before 1906. The essential feature of this instrument was a pair of 90° prisms, so arranged as to rotate on a vertical axis, and ingeniously mounted to be adjustable to different interpupillary distances.

I have used a modification of the Caldwell instrument, similar to the one herein described, for the past seven years and believe that its utility and economy merit consideration. It is useful for intensive study of a small area such as the carpus or tarsal region and equally adaptable for examination of a pair of 14″ × 17″ chest films.

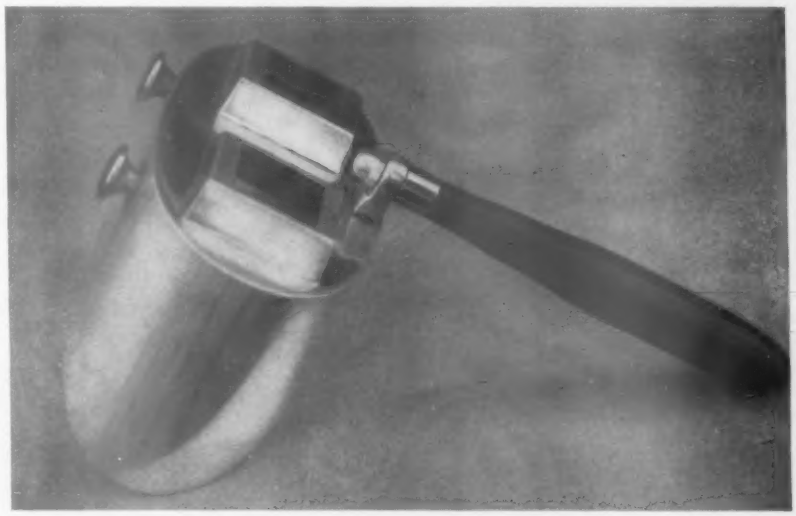

Fig. 1

Two 90° prisms 25 mm. high are mounted on round turntables 58 mm. apart. Adjustment is maintained by a small brake pressing against the edges of the lower pair of turntables. The largest of the three rectangular faces of each prism is silvered; this face is directed medially. The axis of rotation corresponds to the intersection on the triangular base of the lines which bisect the angles. With the axis at this point, rather than at the apex of the right angle, differences of interpupillary width are automatically accommodated for so that it is unnecessary for the distance between axes to be adjustable in a lateral direction. Another simplification is the direct control of each lens separately by knobs on the top of the scope. The hood is wide enough to accommodate the bow of eyeglasses so that their removal will be unnecessary. The center of the handle is set forward from the anterior face of the scope to afford room for the hand grasping the instrument. Likewise the windows are set forward. These are smaller than the turntables to prevent the reflection of light from the sides.

To focus the instrument it is necessary to close the left eye and rotate the right prism bringing each of the stereoscopic pair visible in turn to the right eye. Adjust the lens until the left image is squarely in the field. Without turning the head or moving

[1] Caldwell, Eugene W. The stereoscope in roentgenography. Am. J. Roentgenol., 1918, *5*, 554-558.

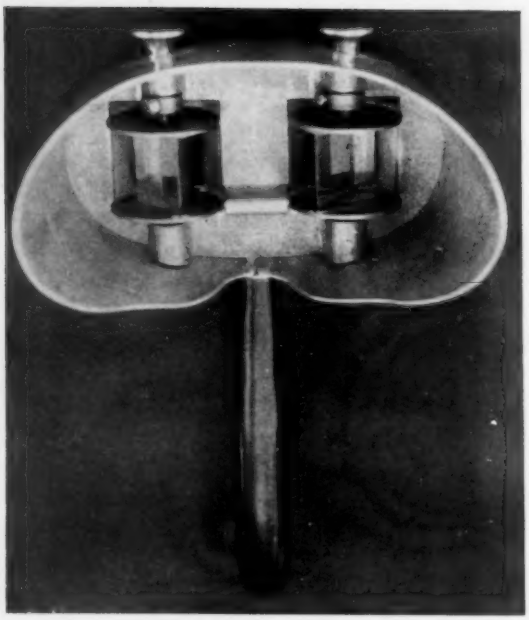

Fig. 2

the hood of the scope focus the left eye on the right image. The instrument is now in focus; slight degrees of adjustment are made by moving the head slightly forward or backward.

If it is desired to view the part from the opposite side, turning the film will not accomplish this as with the ordinary stereoscope; it can be done, however, by focusing the right eye on the right image and the left eye on the left image.

Two or even four exposures may be made on the same film, thus giving antero-posterior and lateral views which may be studied with the ordinary illuminating box. This technique is recommended for its economy of material, time and effort as well as convenience in the stereoscopic study of the film.

USE OF HOODWINK IN PREPARING EYES FOR ROENTGENOSCOPY

By FRANK A. RIEBEL, M.D.

COLUMBUS, OHIO

IT IS an almost universal fault among those who use the roentgenoscope to fail to adapt the eyes by the necessary fifteen minutes' wait in the dark-room. Some roentgenologists use dark glasses for the purpose; but if they are sufficiently opaque to be satisfactory one cannot see to do any useful work.

Some time ago I solved the problem by obtaining a hoodwink, such as is used for initiations into secret societies, etc. This is quite efficient in excluding all light when closed, and is supplied with opaque hinged windows which can be thrown open (Fig. 1).

One of these windows was entirely removed. By donning the hoodwink, therefore, some time before a roentgenoscopy is to be done, one is able to carry on any routine by the use of one eye. When the

Fig. 1

dark-room is reached, the other window is thrown open, or else the hoodwink is removed entirely.

Since roentgenoscopy consists of the observation of a flat plate, depth is not observed and binocular vision is of little value; any observations, therefore, can be made with one eye as well as two.

BOOK REVIEWS

Books Received Are Acknowledged under Heading: Books Received. This must be regarded as a sufficient return for the courtesy of the sender. Selections will be made for review in the interests of our readers and as space permits.

RÖNTGENATLAS DER LUNGENTUBERKULOSE DES ERWACHSENEN. Von Dr. med. Hanns Alexander, Leitender Arzt, and Dr. med. Arthur Beekmann, Oberarzt, des Sanatoriums Agra. Second enlarged and improved edition. Paper, price 36.00 Rm; bound 40.00 Rm. Pp. 493, with 321 roentgenograms and 4 illustrations in the text. Leipzig: J. A. Barth, 1929.

The polymorphous clinical manifestations of pulmonary tuberculosis may be described—in every given case—either in a mere empirical manner, or they may be fitted into a preconceived hypothesis. The latter attitude, much more frequently represented by authors from the other side of the Atlantic, is the keynote of the "Röntgenatlas" under review. By way of introduction, the general features of the task are briefly discussed. The more or less theoretical foundations are built out of a few concepts: (1) the growing evidence that strictly apical tuberculosis is usually benign and not progressive; (2) the recent recognition that subapical foci frequently start and progress suddenly; (3) the possibility and necessity of differentiating roentgenologically between productive and exudative lesions; (4) Ranke's teachings of three fairly well-separated and distinguishable phases in the course of tuberculosis, characterized by different conditions of allergy, immunity, and bacillary propagation.

In the "special part", 149 cases with 307 roentgenograms are presented. The arrangement is clear and methodical; history, clinical and laboratory findings, clinical course, and a brief summary are presented with each case. The various chapters appear under the following headings: "qualitative diagnosis", illustrating the differential diagnosis between exudative and productive lesions; "primary tuberculosis", with cases showing both completely healed and active lesions. In the third chapter, "The different main forms of tuberculosis in the adult" is—in accordance with the general discussion—subdivided into "hilum tuberculosis and its developments", "middle field tuberculosis" where—to the reviewer's surprise—"peribronchial propagation is revived from what had seemed irrevocable death, "infraclavicular infiltration and infraclavicular cavity", "apical tuberculosis", and "miliary tuberculosis". In the fourth chapter, fifteen cases of "fully established isolated phthisis" are presented, grouped as "various disseminated forms", "end-results of productive processes with giant cavities", and "cirrhosis and sequelae". In the next chapter, progressive and retrogressive developments, including spontaneous closures of cavities, are shown. The sixth chapter contains excellent illustrations of the subject "surgical treatment", inclusive of pneumothorax treatment. The last two chapters are devoted to a discussion of pleuritis and differential diagnosis.

The reproductions of the roentgenograms are of high quality, showing all essential detail with clarity. They are wisely selected, so as to illustrate the significant facts in a truly representative way. This book proves well the fact that the roentgenology of pulmonary tuberculosis is a task considerably more involved and much more fascinating than that of diagnosing "pulmonary tuberculosis with or without cavitation."

MAX PINNER

MASTOIDS ROENTGENOLOGICALLY CONSIDERED. (Annals of Roentgenology. Volume I.) By Frederick M. Law, M.D., Roentgenologist, Manhattan Eye, Ear, Nose and Throat Hospital, New York. Second edition revised. Cloth. Price, $12.00. Pp. 42, with 35 plates and 12 text illustrations. New York: Paul B. Hoeber, Inc., 1929.

This book in its new form maintains its former standard of excellence as a short, concise, well-illustrated treatise, shorn of all unnecessary frills. It contains a wealth of practical information for those who are anxious to acquaint themselves with the otological side of roentgenology.

In addition to the discussion of technique and the illustrations of the roentgenological appearances of the various types of mastoid disease and its complications as included in the first

edition, the new volume takes up such innovations as the reformation of destroyed mastoid cells; data concerning the development of the mastoid; the infantile mastoid; demonstration of the superior petrosal sinus; foreign body in the ear; demonstration of the semicircular canals and cochlea; a discussion of the value of stereoscopic films for diagnosis; the application of lipiodol to otoroentgenology, and a unique but important use of mastoid roentgenograms for purposes of identification.

Although the captions for the plates appeared in English, French and Spanish in the first edition, only English is used in the second edition, it being the opinion of the editor and publisher that the English-speaking readers should not be burdened with the extra expense of the translations. It seems most unfortunate that half-tone reproductions of negative prints have been substituted for the beautiful contact prints used in the original edition since this change has robbed the illustrations of much of their value. However, little fault can be found with the book except perhaps to deprecate the scant space allotted to mastoid disease in infants and young children. Both the novice and the older roentgenologist will find it a most valuable aid in that it places the vast experience of an outstanding authority at their command in a concentrated form, and it can be freely recommended as an atlas and a textbook.

CHARLES L. MARTIN

Books Received

THE TREATMENT OF THE COMMON DISORDERS OF DIGESTION: A Handbook for Physicians and Students. By John L. Kantor, Ph.D., M.D., Visiting Physician in Gastrointestinal Diseases, Vanderbilt Clinic, Presbyterian Hospital; Associated in Medicine, Columbia University, etc. Second edition. Cloth. Price, $6.00. Pp. 300, with 88 illustrations. St. Louis: The C. V. Mosby Co., 1929.

PHYSIKALISCH-TECHNISCHES PRAKTIKUM FUER MEDIZINER. Eine Einführung in die Anwendung von Messmethoden und Apparaturen. Von Dr. Phil. Alfred Krethlow, Ehem. I. Assistent am physikalischen Institut der Universität Basel. Paper. Price, RM 15.60. Pp. 232, with 127 illustrations. Berlin: Julius Springer, 1930.

GALL-BLADDER DISEASE: ROENTGEN INTERPRETATION AND DIAGNOSIS. By David S. Beilin, B.S., M.D., Roentgenologist, Augustana Hospital, Chicago, Ill. Cloth. Price, $6.00. Pp. 65, with 130 illustrations. St. Paul, Minn.: Bruce Publishing Co., 1929.

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ABSTRACTS OF ROENTGEN AND RADIUM LITERATURE

ROENTGEN DIAGNOSIS

Head

Badt, Bernhard. Was leistet die Enzephalographie? (Results of encephalography.) *Deutsche med. Wchnschr.*, Sept. 6, 1929, *55*, 1503–1506; Sept. 13, 1543–1546.

The technique of the method is described. As it is not entirely free of danger it should not be used except in doubtful cases, but in such cases it is of great value, particularly in making a differential diagnosis between processes which decrease the ventricle space, such as tumors, and processes of softening. It is also valuable in determining the localization of a tumor. It goes without saying that the results must be interpreted in association with the other findings. Encephalography is almost the only method of demonstrating a hydrocephalus accurately. It may show all transitions from slight rounding of the corners of the ventricle figure to its transformation into a huge hollow space filled with air that does not have any resemblance to the normal ventricle figure. Some authors have found changes in the encephalographic picture in severe trauma, which is of significance in interpreting concussion neurosis.

Among 20 cases confirmed by biopsy or autopsy, encephalography confirmed the author's clinical diagnosis in 4, made a differential diagnosis between tumor and softening possible in 6, contradicted the clinical diagnosis and was proved right by autopsy in 5, did not help in the diagnosis in 3, and the conclusions drawn from it were wrong in 2. Among 27 other cases the encephalographic picture was decisive in the differential diagnosis in 22, in 4 it was of no value and in one in which it indicated frontal tumor no such tumor was found on operation. As autopsies have not been performed in these cases it is impossible to say whether the diagnoses were correct.

Encephalography has also proved of some value in treatment. A number of cases of headache that resisted all other treatment have been improved. And in genuine epilepsy the attacks have decreased or stopped for varying periods of time after encephalography. It has also given excellent results in status epilepticus. In epidemic encephalitis encephalography, possibly repeated, is recommended, not so much because the ventricles are filled with air as because the purulent fluid is removed. For the same reason it is of value in conditions of intoxication, particularly delirium tremens. —*A. G. Morgan.*

Benedict, William L., and Knight-Asbury, Mary. The treatment of malignant lesions of the eyelids. *N. York State J. M.*, June 1, 1929, *29*, 675–677.

Malignant lesions of the eyelids are usually situated along the margin of the lid or near the canthus. The growth may be primary, and single or multiple. It may be an extension of lesions in the skin of the nose or cheek to the eyelid. Multiple lesions are usually of low-grade malignancy, grow slowly, and yield to treatment more satisfactorily than the solitary and usually more malignant lesions.

The authors have used radium in the treatment of small basal cell tumors with uniform success. In tumors, however, which have fibrous bases, results are not so favorable. Radium is also regularly employed as a placebo in cases of inoperable carcinoma of the orbit. In forming conclusions with regard to the use of radium, no decision of the effect of its action can be determined without a general consideration of the many factors influencing its employment. The dosage and the probable depth of efficient penetration must be considered. The malignancy of the tumor must be taken into account. Thus, while there is little difference in the degree of malignancy of rodent ulcers, there is considerable difference in the malignancy of squamous cell epitheliomas.

Roentgen rays are effective in certain. superficial tumors of low-grade malignancy They are considered inferior to radium in most cases of epithelioma, and are now but seldom used as the single therapeutic agent.

The authors have found that the most effective method of eradicating malignant lesions of the eyelids is excision followed by treatment with radium, by diathermy or by fulguration. From 1918 to 1927 inclusive, 251

patients were treated for rodent ulcer of the eyelids and of this group, 98 were treated by radium. Ten per cent were considered cured at the close of 1927. It was impossible to get reports from all these patients. Many did not return after the first treatment. In the group of 98 patients there were 27 known recurrences.

Eighty-seven patients were treated by excision of the lesions followed by treatment with radium. There were 11 reported recurrences. Two of these were cured by subsequent treatment.

Excision by knife and cautery was performed in 29 cases, without any known clinical recurrence. Surgical diathermy was primarily used in 25 cases and in this group there were 5 known recurrences.—*R. S. Bromer.*

Quinn, Lester H., and Meyer, Ovid O. The relationship of sinusitis and bronchiectasis. *Arch. Otolaryngol.*, August, 1929, *10*, 152–165.

The authors call attention to the fact that a number of patients have symptoms of tuberculosis and yet do not have the disease, but frequently have bronchiectasis associated with an unrecognized sinus infection. Twenty-two of the 38 patients with bronchiectasis studied by them were found to have a coexistent sinusitis, and a majority of these had no symptoms of sinusitis. The authors could not establish any relation between the degree of sinusitis and the degree of bronchiectasis.

In an effort to demonstrate the relation of sinusitis and bronchiectasis, the authors introduced iodized oil into the nasal fossae, and aspiration of the oil into the lung occurred in 5 out of 11 patients while sleeping. Aspiration occurred so easily that the authors believe it is logical to assume that aspiration of pus draining from the maxillary ostium may also be simple and is possibly the most important explanatory factor for the frequent concomitance of bronchiectasis and sinusitis. —*E. P. Pendergrass.*

Wolf, George D. The study of antrum disease with the aid of injection of iodized oil. *N. York State J. M.*, Feb. 15, 1929, *29*, 193–198.

Wolf reports 8 cases of sinusitis involving the antrum in which he used antral injections of iodized oil as an aid in diagnosis. The roentgenogram of one case is shown to illustrate the normal appearance of an injected antrum. The injection proved useful in the diagnosis of thickened and hypertrophied mucous membranes lining the antrum, and in cases of acute polyposis. He believes this method has not met with the enthusiasm which it merits on the part of both the roentgenologist and the rhinologist. He regards it as a great help in the diagnosis of obscure cases. The roentgenograms of several pathological conditions are shown. —*R. S. Bromer.*

Hamlin, Fred E. Calculus of the submaxillary gland and duct. *Arch. Otolaryngol.*, August, 1929, *10*, 177–187.

The author reports 4 cases of submaxillary calculus. He believes that they occur more often than the literature would seem to indicate. The symptoms are pain, especially at meal time, which is usually associated with a circumscribed swelling of the submaxillary gland. The calculi are rich in mineral salts and cast a dense shadow on the roentgenogram. A calculus in the anterior two-thirds of Wharton's duct can be demonstrated by an intraoral film placed horizontally between the teeth. The film is exposed from beneath the lower jaw. When it lies in the posterior third of Wharton's duct, lateral views of the neck are best. The author outlines the different methods of treatment. In this article, the author reviews the anatomy and physiology of the submaxillary gland.—*E. P. Pendergrass.*

NECK AND CHEST

Fishberg, Maurice. Apical and subapical tuberculosis. *Brit. M. J.*, Aug. 24, 1929, *2*, 331–334.

Fishberg states that of the 60 to 90 per cent of tuberculous foci, observed in routine necropsies, 30 to 60 per cent are found to be "obsolete." It appears that a large proportion of tuberculous lesions of the lungs heal spontaneously. The great problem has been to differentiate these benign lesions from the numerous others that are progressive and require treatment, be it climatic, institutional or operative.

With the more universal application of roentgen rays in the diagnosis of pulmonary pathological conditions, there has taken place

in the last five years a radical change in the earlier views of the early localization and evolution of tuberculous lesions in the lungs. It has been observed that in a decidedly noteworthy proportion of active and progressive cases the first lesions—those responsible for the initial symptoms of the disease—are located below the clavicle, while the apices remain free from pathological changes for some time. Further research has confirmed the traditional teaching that apical lesions are very common, more common than those located below the clavicle, but they are, in the vast majority of cases, sclerotic in nature and display no tendency to cause symptoms of phthisis, which are disabling and lead to a fatal issue. In fact it appears that these apical lesions are the ones that are so often found at necropsies of patients who died from other causes, and who during life had not suffered from disease of the lungs.

The vast majority of tuberculous lesions of the lung are found at the apex, and they remain circumscribed to that region. Nearly all lesions which have cicatrized, remain inactive. They are often discovered clinically and with the aid of the roentgen rays during the course of periodical examinations of the healthy. In patients with extrathoracic tuberculous lesions, who are referred for chest examination, the tuberculous lesions are almost invariably found in the apex. But these patients hardly ever suffer from significant pulmonary symptoms. They are diagnosed as tuberculous by ultra-cautious physicians and they supply the "early" and the "curable" cases considered ideally suitable for sanatorium treatment. During recent years there has appeared evidence to the effect that lesions limited to the apex of the lung only exceptionally develop into active and progressive tuberculosis which requires treatment and which is the cause of death in about 10 per cent of civilized humanity.

Pulmonary tuberculosis of more serious progressive significance generally begins differently and the lesion is usually located below the clavicle in a majority of cases. These cases usually have an abrupt onset, and the roentgen examination may reveal a soft, cloudy patch, isolated in the midst of apparently healthy lung tissue, just below the clavicle and often toward the axillary portion of the lung. The nature of the patch is bronchopneumonic, of the type seen in primary tuberculosis in children, or in tuberculous pneumonia in adults. In most cases it is found on a level with the second or third interspace, but it may be located lower down, even in the lower lobe. It may be small, the size of a cherry, or larger involving the greater part of the upper lobe. The apical regions appear free from pathological changes. The shadow may be clear-cut and distinct, but in most cases it has an irregular outline. Inasmuch as softening of the caseous material may take place rapidly, the formation of excavations occurs at times very soon, and at the first roentgen examination signs of an isolated cavity surrounded by a thin shell in the midst of unaltered lung may be found. These early lesions occur mainly in young persons and adolescents, though Fishberg has met with many in persons over forty-five years of age.

At first it was considered that these lesions, subapical in type, were mainly found in persons who had been unduly exposed to tuberculosis, such as doctors, nurses, relatives of patients with active tuberculosis and the like. But further observation has shown that many more cases are discovered in individuals who have not been unduly exposed to potential sources of infection. The nature of these lesions has been the subject of considerable discussion. Anatomic and roentgenographic studies of tuberculous lesions of this type in children and in adults show clearly that they are bronchopneumonic. The recently emphasized fact that they often undergo involution—that is, are absorbed without leaving any trace—is interesting, even though it has been known for a long time that tuberculous lesions are often absorbed.

The prognosis in apical lesions is more favorable than in the subapical. Blood-spitting is about as common in one group as the other. Copious hemorrhages are more common in patients with subclavicular lesions.

The progress of the subclavicular lesion can be followed only with the aid of serial roentgenograms. The lesion may remain unaltered for weeks or months. With improvement in the general condition involution may take place and the infiltration is absorbed, leaving merely linear markings denoting fibrosis. In other cases, signs of thickened inter-

lobar pleura remain. In rare instances, calcification of the lesion takes place and there remain sharply demarcated, homogeneous spots immediately below or above the clavicle. In active and progressive lesions the process usually extends upward, involving the summit of the lung, and there results the common variety of chronic phthisis in any of its protean forms. In some patients the infiltration extends upward and downward, so that an entire lobe is involved in a short time, at times a whole lung, and the clinical picture is then that of acute pneumonic phthisis.

In a large proportion of cases the lesion caseates, softens, is expectorated, and finally leaves an excavation. As a rule when these cavities form early they are only revealed by the roentgen examination, not by physical signs. They have certain characteristics which differentiate them from cavities formed later in the disease. They appear in the roentgenogram as spherical or oval in shape, isolated in the midst of apparently healthy lung tissue, surrounded by a sharply demarcated border consisting of a thin or moderately thick wall; in exceptional cases a shifting fluid level may be noted at the most dependent part. They are usually situated just below the clavicle, may be multiple or may coalesce to form the well-known honeycomb picture. Cavities formed later in the disease have thick walls, surrounded by infiltrated lung tissue in contrast to the early cavities surrounded by healthy lung tissue. In exceptional cases the early cavities heal, the circular shadow disappears, leaving linear markings pathognomonic of fibrosis, or at times they leave no trace at all. In fact, some authors have for this reason spoken of these "annular shadows" as representing pleural adhesions, localized pneumothoraces, etc., and not at all as excavations of the parenchyma. But more careful studies, Fishberg claims, have shown conclusively that, with rare exceptions, they are cavities even though they heal. In many cases of subclavicular infiltrations the lesion spreads along the lymphatics so that on the roentgenogram there are dots and spots running from the original lesions outward and downward. In still others, caseating areas suddenly appear in other parts of the same or the contra-lateral lung.

Prolonged and costly treatment is unnecessary in the vast majority of apical cases. Large proportions of the subclavicular lesions are in need of careful attention. They are benefited by rest, at home or in institutions, and some require artificial pneumothorax. —*R. S. Bromer.*

Opie, Eugene L., Landis, H. R. M., McPhedran, F. Maurice, and Hetherington, H. W. Tuberculosis in public-school children. *Am. Rev. Tuberc.*, Oct., 1929, *20*, 413–420.

Tuberculosis as recognized by the customary methods of medical inspection in schools is manifested by physical signs, loss of weight, fever, and other symptoms. These reveal children with clinical tuberculosis who may then be removed from the schools and be under conditions that favor their recovery. Sanatorium treatment gives these children with manifest tuberculosis the best chance of recovery. There is, however, another large group of children with advanced tuberculous infection that presents greater difficulties to the medical examiner because they are unaccompanied by symptoms or physical signs.

Tuberculous infection is recognizable by the tuberculin test but the test cannot be used to determine the severity of the infection. Roentgenological examination is the only means by which the position and extent of latent tuberculous lesions can be determined.

Prophylactic care controlled by repeated physical and roentgenological examinations furnishes a means by which advanced latent infection may be arrested before it has developed into clinically manifest disease. Children with the following conditions should receive special care in nutrition-tuberculosis classes or by some other regimen adapted to their needs and they are suitable for admission to a preventorium if it is available.

(1) Manifest pulmonary tuberculosis with no symptoms, physical signs or roentgenological evidence indicating that the lesion is active. Such children have usually been treated in a sanatorium and have been discharged because the disease is regarded as arrested. Sputum if present must be demonstrated to be free from tubercle bacilli.

(2) Latent apical tuberculosis. Lesions that in roentgenological films have the appearance of activity or are progressive on repeated roentgen examination should receive sanatorium treatment.

(3) Latent tuberculous infiltration of the lung often associated with tuberculosis of tracheobronchial lymph nodes. In some instances, particularly in older children, these lesions are the scars of preexisting infection. Evidence of activity or extension indicates the need of sanatorium treatment.

(4) Tuberculosis of tracheobronchial lymph nodes, even though partly calcified: (*a*) when the child is still in contact with open tuberculosis; (*b*) when the reaction to tuberculin is unusually intense; (*c*) when the lesions are unusually large or very numerous; (*d*) when they are associated with evidence of impaired health perhaps not referable to tuberculosis and including advanced underweight.

The study of contagion of tuberculosis in families exposed to open tuberculosis has shown that children with the lesions just described are apt to develop manifest disease, but it is not assumed that the foregoing groups include all of the children who will develop manifest tuberculosis.

The following types of tuberculous infection are widely prevalent among healthy children and do not require special care:

(1) Infection demonstrated by a positive tuberculin reaction without lesion demonstrable by roentgenological examination even though there is contact with open tuberculosis. (Repeated examinations are however essential for all children in contact with open tuberculosis.)

(2) Circumscribed nodules in the lung substance that have undergone calcification.

(3) Roentgenologically demonstrable tuberculosis of tracheobronchial lymph nodes that are partly calcified, except under the conditions outlined above. Sharply defined, very opaque lesions are likely to be healed or healing.

These observations have not decisively determined whether tuberculosis is transmitted by contagion within the schools. It is evident that in school buildings of such modern construction that overcrowding is prevented the medical inspection of school children with few if any exceptions reveals the disease before the child begins to expel tubercle bacilli. Nevertheless in the absence of the methods directed to discover latent tuberculosis it is inevitable that rapidly progressive tuberculosis, particularly in adolescent colored children, will occasionally be far advanced before it is recognized. In one school (School A) high incidence of tuberculin reactions has suggested that infection was acquired within the school. It is noteworthy that this school has been subsequently transferred to a new, spacious building. The possibility of contagion within the schools can be eliminated only by the use of methods that will reveal grave tuberculous infection before it has impaired health.—*E. P. Pendergrass.*

HETHERINGTON, H. W., MCPHEDRAN, F. MAURICE, LANDIS, H. R. M., AND OPIE, EUGENE L. A survey to determine the prevalence of tuberculous infection in school children. *Am. Rev. Tuberc.*, Oct., 1929, *20*, 421–510.

A study of the contagion of tuberculosis made at the Henry Phipps Institute demonstrated that tuberculosis of the lungs and pulmonary lymph nodes in children is often far advanced before it impairs the health. It showed that certain forms of latent infection foretell the approach of clinically recognizable tuberculosis; for in children in whom tuberculosis of the tracheobronchial lymph nodes has been discovered by roentgenographic examination, tuberculosis of the lung parenchyma may progress so far that the disease is manifested by symptoms and physical signs.

The authors show numerous graphs and drawings illustrating the pathology found in the group studied. Their conclusions are that tuberculin tests of school children of Philadelphia show that 37.7 per cent are infected with tuberculosis at the age of five years and 90.2 per cent at the age of eighteen years. Their figures indicate that there has been no significant diminution in the incidence of tuberculous infection in childhood to correspond with the diminution of mortality from tuberculosis in recent years.

The intracutaneous tuberculin test is the only accurate method of determining the incidence of tuberculous infection in apparently healthy children. Accurate information concerning the frequency of infection at different ages in children of different localities, preferably repeated at periodic intervals, would give valuable information concerning the epidemiology of tuberculous infection.

American-born children of Italian parentage have shown a low incidence of tuberculous infection as indicated by the tuberculin test.

In Jewish children the incidence of the positive reaction has been approximately the same as that of other children.

Pulmonary tuberculosis recognized by roentgenological examination in association with symptoms and physical signs is found in 0.5 per cent of children attending school, being more frequent in high-school children than in children of elementary schools. Sanatorium treatment or its equivalent offers to these children the best chance of recovery from the disease.

Latent apical tuberculosis recognizable in roentgenograms is often the precursor of the adult type of pulmonary tuberculosis. It is found in 1 per cent of adolescent children (of high-school age) and is more frequent in girls than in boys. Children with this lesion should be under continuous observation and should pursue a modified high-school regimen directed to prevent further progress of the lesion.

Latent tuberculous infiltration of the lung of childhood type was found in more than 1 per cent of the children. This lesion may be the precursor of grave disease. Children who have it should be kept under observation and should receive special care until it is evident that the lesion is no longer progressive.

Latent tuberculous foci in lungs and tracheobronchial lymph nodes are found in more than 10 per cent of the school children. It may be the precursor of pulmonary tuberculosis. It varies from massive caseous lesions of serious import to firmly calcified foci, which are evidently healed. Its significance is determined by the size of the lesion, the activity of tuberculin reaction, continued exposure to open tuberculosis, associated changes in the lung substance and the age of the child.

Pulmonary tuberculosis recognized by roentgenological examination together with symptoms and physical signs is found more than twice as often in adolescent girls as in boys of the same age. Our figures indicate that it is approximately four times as frequent in colored as in white children of high-school age.

The evidence we have obtained suggests that tuberculous infection may spread within schools but under the existing system of medical school inspection this seldom occurs.

—*E. P. Pendergrass.*

O'Brien, E. J. The indications for the surgical treatment of pulmonary tuberculosis. *Am. Rev. Tuberc.*, Nov., 1929, *20*, 787–808.

The author states that the indications for surgical interference in the treatment of pulmonary tuberculosis are a delicate and intricate problem, and each case must be considered by itself. It is his feeling that every demonstrable and unilateral tuberculous lesion should have some form of compression therapy. He calls attention to the fact that many lesions clear up without compression, but he feels that even compression in these cases is indicated.

Before applying any form of compression therapy intimate knowledge of the various factors must be considered in respect to the indications for surgical treatment. These are as follows: (1) The pathological and anatomical characters of the lesion ("qualitative diagnosis"), such as predominantly exudative, or predominantly productive, or cirrhotic, or mixed, and in a further subdivision one has to differentiate those exudative lesions showing only slight infiltrations and those having the characteristics of caseous pneumonia. Productive lesions may be either localized nodular foci or scattered nodules of from almost miliary size to massive aggregations. (2) The dynamics of the lesion, that is, its differentiation as to clinical signs; hemorrhage with small or large amount of sputum; or without sputum; or the sputum containing tubercle bacilli or not. (3) Extent of lesion according to the usual classification of "Diagnostic Standards," with particular emphasis on the question of unilaterality. (4) Localization: whether apical, infraclavicular in the middle field, basal, or diffuse. (5) Presence, size, character, localization, and number of cavities. (6) Complications: such as pleural involvement, pneumonoconiosis, and other types of nonspecific fibrosis and cardiac disturbances.

It is the author's belief that the treatment of tuberculosis must aim to stop or prevent the destructive process which occurs during the first six months, and to aid in repair afterwards if the danger has been done. He delineates the various procedures in this type of therapy.

Phrenic operations cause paralysis of the diaphragm with subsequent elevation causing compression of the lung. Paralysis may be

temporary or permanent. A simple crushing of the phrenic nerve is used in minimal lesions. Artificial pneumothorax may be just as efficient but has more complications than the phrenic operation. In predominantly exudative lesions that are rapidly progressing and active the phrenic operation should not be considered. This type of lesion needs the greater amount of compression afforded by artificial pneumothorax.

Tuberculous pneumonia, if seen early, should be combated at once with artificial pneumothorax. Compression should not be employed in cases with compensating emphysema as it may aggravate the emphysematous condition of the lung. "When considering compression of the diseased lung and there are suspicious lesions in the contralateral lung which we wish to test out artificial pneumothorax should always be applied first."

Cavities in the vertebral gutter are not readily amenable to compression therapy from phrenic operation because of their proximity to the attachment of the diaphragm. Early basal tuberculosis is sometimes completely controlled by phrenicectomy. A patient with uncontrollable hemorrhage, even if the disease is bilateral, should have compression by air, and if possible on the side on which the bleeding occurs, if this can be determined. If this cannot be done, a phrenic crushing is indicated.

In cases in which there are adhesions between the lung and chest wall one of three procedures is chosen; phrenicectomy, intrapleural pneumolysis, and thoracoplasty. Various types of these operations and their indications are discussed.

The authors discuss the difficulty in obliterating some of the cavities in the lung and the methods of controlling and handling such difficulties. True apical tuberculosis has been found to run a rather benign course and very seldom requires compression therapy.

The author concludes his excellent paper by stating that we now have a better conception of pulmonary tuberculosis and he believes it an acute destructive process, and that this destruction progresses in most cases in spite of bed rest. He makes a plea for more universal treatment of these lesions by some form of compression therapy early in the disease before hopeless destruction has taken place.—*E. P. Pendergrass.*

POLLAK, M. Bilateral artificial pneumothorax complicated by spontaneous pneumothorax. *Am. Rev. Tuberc.*, Nov., 1929, *20*, 767–771.

The author states that bilateral artificial pneumothorax is slowly taking the place it deserves in our therapeutic armamentarium. The thought that by bilateral pneumothorax one may enhance the severity of untoward complications that occasionally follow collapse therapy and so jeopardize the life of the patient holds back many a phthisiotherapist from applying this rather heroic measure in cases in which it seems to be clearly indicated. The author reports one case in which a bilateral artifical pneumothorax was utilized with distinct advantage in controlling a severe hemorrhage, though the disease is still progressing.—*E.P. Pendergrass.*

FISCHER, ANTON. Ein Fall von gummöser Lungensyphilis. (A case of gummatous syphilis of the lungs.) *Deutsche med. Wchnschr.*, Oct. 11, 1929, *55*, 1721–1722.

The patient was a man aged fifty-one who had had syphilis in 1904 and had had several treatments for it, though evidently insufficient ones. He came for treatment in April, 1928, for pain and swelling of the hands, feet and knees and palpitation of the heart on exertion. He had no lung symptoms, no cough, no expectoration. Examination of the thorax showed several round sharply circumscribed homogeneous shadows about the size of quarters in the right middle lung field near the wall of the thorax. The heart was the shape of the heart of cards with a longitudinal diameter of 16 cm., the aorta broadened, the vessel shadow 10 cm. broad. Both hip-joint fissures were narrow and slightly shadowed, the outline of the left acetabulum indistinct. The roentgen picture of the left knee-joint showed a marginal ridge at the edges of the tibia and femur and vitreous structure of the bone. In the right hand there was loosening of the periosteum of the basal phalanges; the interphalangeal joint fissures were narrow and shadowed. Under antisyphilitic treatment the joint symptoms disappeared and the palpitation decreased. The shadows in the right middle lung field disappeared completely. The shadows in the lung were evi-

dently due to gummatous syphilis. The disease of the lungs had been entirely latent and had not caused any symptoms at all. In addition to the lung disease there was mesaortitis and chronic polyarthritis; the latter was probably syphilitic also but as no joint puncture was obtained this could not be proved.—*A. G. Morgan.*

Lipschitz, M. Ueber die Zunahme des Bronchuskarzinoms im letzten Jahrzehnt und die diagnostische Bedeutung der Bronchographie. (The increase in carcinoma of the bronchi in the last decade and the value of bronchography in its diagnosis.) *Deutsche med. Wchnschr.*, Oct. 11, 1929, *55*, 1708–1711.

There is no doubt that carcinoma of the bronchi or primary lung cancer has greatly increased in recent years almost everywhere. In the region of the author's hospital at Zwickau the figures are twice as large for the last decade as for the preceding one, and similar figures are found for most regions. Some authorities say this is due to the war and the influenza epidemic but the author thinks it is caused to a much greater extent by external causes, such as occupation and housing and the injury to the populace from mechanical and chemical irritations. Dust from industrial plants is a particularly important factor in causing it. A comparison of the figures for his region, which is an industrial one, with those for Utrecht in Holland which is a non-industrial one, shows that the increase has been much greater in the former.

The symptoms of bronchial cancer are not at all characteristic in the early stages. The cancer originates in the mucous membrane of the bronchi. The classical symptoms given in the textbooks were not seen in one of the author's cases. Most of the patients complained of irritating cough and dyspnea. He saw the so-called raspberry jelly sputum in only one out of 41 cases, and sputum mixed with blood in only 4 cases. Roentgenoscopy was a valuable aid in diagnosis but even it failed sometimes. Among 17 cases autopsied from 1922 to 1925 only 4 had been correctly diagnosed. And a mistaken diagnosis of tumor of the lung was made in 2 cases, one of empyema and another of chronic pneumonia. A great advance was made in diagnosis when bronchography was introduced. Since 1925 when bronchography was introduced the curve of correct diagnoses has steadily risen and that of mistaken diagnoses constantly decreased. In 1928, 18.7 per cent of the cases were not diagnosed. Bronchography could not be carried out in all cases because the patients were in such bad condition. It requires correct technique and a certain amount of practice. In many cases in which simple roentgen examination gave doubtful results the diagnosis was rendered certain by bronchography so it should be practised in all cases in which the condition of the patient permits.—*A. G. Morgan.*

Brdiczka, Georg. Bronchographie mittels praktischer vereinfachter Methode. (Bronchography by a simplified practical method.) *Deutsche med. Wchnschr.*, Aug 9, 1929, *55*, 1341.

The best method of bronchography is to anesthetize the larynx and then introduce a small hollow sound between the vocal cords into the trachea and then after putting the patient in position inject the iodipin. Some authors use a complicated apparatus for this but the author describes a very simple method. He uses a soft or semi-rigid rubber catheter about 20–30 cm. long and about 3 to 4 mm. thick. It is pulled through a cork that has a hole bored in the middle of it so that the cork lies near the posterior end of the catheter. The sound is grasped in the middle with dressing forceps and after anesthesia of the larynx introduced between the vocal cords. Care must be taken to see that the bend produced by the forceps is at about the same angle as that of the axis of the larynx with a horizontal line drawn through the mouth. As this angle varies in different individuals and cannot be determined in advance the sound is bent at a certain angle and introduced. If it strikes the posterior wall of the larynx the angle is enlarged until it passes. It is generally not possible to introduce the sound without the forceps because it strikes on the posterior wall of the larynx and will not pass. When the sound has passed the vocal cords it is pushed in quickly as far as possible without obstruction. Then the patient is told to bite down on the cork and close his lips. The sound is held firmly in this way so it cannot be aspirated or retched out. The patient is then placed on the table in the right position

and the iodipin injected. The sound with the cork is then taken out and the picture made. It is not necessary to sound the bronchus for the position of the patient directs the oil in the right way. Bronchoscopy immediately after the filling is not necessary and is even a disadvantage because it increases the irritation which causes coughing so that the bronchi are less completely filled. The author has used this method in many dozens of cases in the last three years and has had very good pictures without any bad by-effects. The duration of the whole process, including the anesthesia, is ten to fifteen minutes. There is very little subjective disturbance for the patient and the author recommends the method highly.—*A. G. Morgan.*

FARRELL, J. T. Roentgen diagnosis of intrathoracic neoplasms. *Radiology*, July, 1929, *13*, 1–14.

Pulmonary cysts of congenital origin, teratomata, dermoids and unruptured hydatid cysts present quite characteristic roentgenologic appearances, according to Farrell. Mediastinal tumors of lymphatic origin are also fairly characteristic; they respond well to roentgen therapy, and an exposure to a therapeutic dose of roentgen rays may make possible a differential diagnosis between these tumors, substernal thyroid and extrabronchial carcinoma. Metastases of some varieties notably the nodular and miliary, are readily diagnosed. Infiltrative and massive changes in the lungs, while not always definitive of themselves, are pathognomonic when associated with a known primary malignant tumor of some other organ. Extrabronchial pulmonary carcinomata, while they usually have characteristics which establish them as new growths, may be confounded with mediastinal lymphatic tumors. Endobronchial (bronchial) carcinomata present the greatest problem in the diagnosis of intrathoracic tumors. The signs which they present depend on their age and point of origin. The direct sign of endobronchial carcinoma is a mass due to the presence of a tumor, to which collapse, infection or metastasis may be traced as secondary phenomena. The indirect signs are similar to those of bronchial foreign body.—*J. D. Camp.*

RÖSLER, H. Über Herzvergrösserung bei angeborener arteriovenöser Kommunikation. (Enlargement of the heart in congenital communication between the arteries and veins.) *Klin. Wchnschr.*, Aug. 27, 1929, *8*, 1621–1623.

A case is described in a girl fifteen years of age who had a congenital anomaly of the vessels of the right hand consisting of a communication between the arteries and veins. This diffuse idiopathic phlebarteriectasia is typical but rare. The girl was sent to the author with a diagnosis of cirsoid aneurysm of the right hand to have a roentgen examination made to see whether there were any changes in the bones of the forearm. There were none, but as cases have been described in the literature in which the heart was enlarged when there was an abnormal communication between the arterial and venous circulation the author took a picture of the thorax and found that the heart was moderately enlarged. Brief abstracts are given of a number of cases from the literature in which the heart was also enlarged, contrary to the statement of the American authors, Reid and Rienhoff, that it is not enlarged in this condition.

As the enlargement of the heart recedes after the abnormal communication is overcome, by amputation for example, it proves that there is an etiological connection between the two conditions. In a few cases the heart is not enlarged. As in traumatic communications between the arterial and venous systems there may be murmurs over the heart which may simulate valve lesions, such as insufficiency of the mitral or aortic valves.—*A. G. Morgan.*

KEEFER, C. S., and HSIEH, C. K. The x-ray examination of the heart in beriberi. *Radiology*, September, 1929, *13*, 211–215.

For some time Keefer and Hsieh, of Peking Union Medical College, have been interested in the cardiac changes observed in beriberi. They have found that in all cases of beriberi with cardiac insufficiency the heart was enlarged and there was also considerable enlargement in cases without insufficiency. The enlargement was principally right sided, involving both the right auricle and ventricle, and the pulmonary artery was prominent in many. There was also enlargement of the superior vena cava. The size and configuration of the heart changed completely following treatment, and it assumed a normal size and

shape after a varying length of time.—*J. D. Camp.*

Udaondo, Carlos B., and Vadone, Atilio. The pathogenic mechanism of the Kienboeck phenomenon. *Am. Rev. Tuberc.*, Nov., 1929, *20*, 741–763.

In the year of 1898 Kienboeck published observations on a case of pyopneumothorax and termed these observations as paradoxical movements of the diaphragm. Since that original observation numerous authors have made similar ones, but there has been some variance of opinion as to the cause of these findings.

In Kienboeck's first explanation he stated that the diaphragm yielded because of the pressure of the fluid when it was released in expiration and was made hollow and became concave; but on the contrary it was flattened at inspiration, because of which this concavity disappeared and the fluid therefore arose.

In his second explanation he invoked the hypothesis of paralysis of the diaphragm, and then it was the intra-abdominal pressure which while increasing at inspiration because of the descent of the normal diaphragm pushes open the paralyzed diaphragm and makes it ascend.

The authors of this paper have made excellent observations on carefully controlled subjects. The study was made with a combined observation of pleural pressure and roentgenoscopic observation during the procedure. The patients were placed in the erect and recumbent positions, and each lateral in the horizontal position. They divided their observations as follows: (1) Kienboeck's phenomenon in pneumothorax, (2) paralysis of the diaphragm in pneumothorax.

The authors did not agree that the diaphragm was affected in pneumothorax and they proved this to their own satisfaction by doing a phrenicotomy on the same patient later, and then the observations were entirely different. Before phrenicotomy the diaphragm was flattened. Afterwards it was convex.

The phenomena are quite different and are discussed at great length by the authors. They also discuss the image of the diaphragm seen at the time of the roentgen examination. They explain some of the adhesions of the costodiaphragmatic angles as being due to adherent inflammatory processes or a retractile sclerosis of the lung.

They were able in succeeding experiments to demonstrate to their own satisfaction that the intra-abdominal pressure had nothing to do with, or only in a slight measure, the elevation of the dome of the diaphragm.

The article does not lend itself to abstracting as almost the entire discussion is of importance. The observations may be summarized as follows:

First, pneumothorax with paralysis of the diaphragm due to phrenicotomy. In this class of patients Kienboeck's phenomenon was always observed with whatever intrapleural pressure was present and in whatever position the patient was placed.

The second class was simple pneumothorax without paralysis of the diaphragm. In this group the phenomenon occurs in a certain number and a fixed number of cases. The Kienboeck phenomenon is never present in simple pneumothorax when the pressure is negative at expiration. On the contrary, in all cases in which it is observed positive pressures are always found at operation. This balancing movement is always slight and is modified by different positions. In decubitus on the side of the pneumothorax or subject who is standing strongly inclined to that side the Kienboeck phenomenon generally disappears and is replaced by more or less ample respiratory contractions of the diaphragm. In the opposite decubitus or in the standing position inclined in the opposite way reappearance of the paradoxical movement is favored.

The Kienboeck phenomenon does not appear in all cases with positive pleural pressure at expiration. This may be due to the fact that the lung remains more or less adherent to the diaphragm or because the positive pressures had not yet sufficiently displaced it at expiration to place it below the position which it should occupy at inspiration.

The pathogenicity of the Kienboeck phenomenon is discussed in paralysis of the diaphragm, pneumothorax, and pyopneumothorax. —*E. P. Pendergrass.*

Vadone, Atilio. Radiological signs permitting the diagnosis of paralysis of the diaphragm coincident with pneumothorax. *Am. Rev. Tuberc.*, Nov., 1929, *20*, 736–740.

The author states that there is a mutual dependence between the muscular action of the

diaphragm and the elastic action of the lung. He discusses the roentgenological signs permitting the diagnosis of paralysis of the diaphragm coincident with pneumothorax in the light of Kienboeck's observations in 1898. He also discusses the observations of numerous other authors who have been working with this particular phenomenon.

A summary of the findings is as follows:

With paralysis of the diaphragm	*Without paralysis of diaphragm*
1. Position of diaphragm	
At inspiration higher than that of normal side.	At inspiration lower than that of normal side.
2. Contour of diaphragm	
Always clear and well outlined at expiration as well as at inspiration.	The contour was modified on passing from expiration to inspiration, with the appearance of irregularities and festoonings.
3. Kienboeck phenomenon	
Constant, with whatever pressure and in whatever position in which the subject is placed. Generally of great amplitude.	Never noted when the intrapleural pressure at expiration is negative. When it exists, it is of slight amplitude and coincides always with positive pressures at expiration. Disappears easily by modifying the pressure in the sense of making it negative, or by simply inclining the subject on the side of the pneumothorax.

—*E. P. Pendergrass*

McFADDEN, G. D. F. Congenital diaphragmatic hernia. *Brit. M. J.*, July 13, 1929, *2*, 45–46.

McFadden reports a case of congenital diaphragmatic hernia. The patient was operated upon with excellent result, the roentgenogram made after operation showing that the lung on the left side at the site of the hernia, had returned to normal. He cites the following points of interest in the case:

1. Although the opening was evidently congenital, the patient had no symptoms until he was four years old. A thin membrane may have prevented herniation.

2. The symptoms were all referred to the abdomen.

3. The incision, planned so as to pass through the hernial orifice, made the reduction easy, and it did not appear to cause unnecessary shock.

4. The hernia was of the type most commonly found. It was situated on the left side at the point where the two embryonic migratory muscle elements meet—that is, those fibers developed from the ventral longitudinal muscle sheath and those from the subvertebral muscle mass. There was no peritoneal sac.

5. The contents were small and large intestines and omentum. The stomach and spleen were in their normal position.

6. The pleural cavity was opened without respiratory disturbance due to mediastinal adhesions.

7. The lung re-expanded without positive intratracheal pressure, and in spite of the irritation of that half of the diaphragm due to the surgical intervention.—*R. S. Bromer.*

ABDOMEN

LARIMORE, JOSEPH W. The alimentary tract in pulmonary tuberculosis. *J. Missouri M. Ass.*, March, 1929, *26*, 105–111.

Intestinal disturbances in tuberculosis should be thought of from two viewpoints: (1) that of intestinal symptoms in pulmonary tuberculosis, and (2) that of symptoms of true intestinal tuberculosis.

(1) Constipation is the most frequent intestinal symptom in the patient having pulmonary tuberculosis. Associated symptoms are, bloating, abdominal gas, sometimes real distention, abdominal cramps and diarrhea. The latter is very often a disturbing and serious symptom.

(2) Symptoms of alimentary localization of tuberculosis include pain, constipation, diarrhea, nausea and vomiting, palpable tenderness and exacerbations of systemic symptoms. Localization of tuberculous involvement usually centers around the ileocecal valve.

Roentgenology holds an important position in the diagnosis or elimination of alimentary tuberculosis. Roentgen observation shows, in secondary intestinal tuberculosis, alterations of the intestinal contour by filling defects and spasm, with associated disturbances of alimentary motility. Early secondary tuberculosis is more frequently localized in the ileocecal segment. The associated direct and reflex derangements of gastrointestinal function as revealed by the roentgen-ray study are variable. Marked gastric motor delay with gastric hypertonicity, total intestinal hypermotility with complete evacuation of barium in eighteen to twenty-four hours, or with barium found in the distal colon or rectum at the end of six hours in spite of gastric motor delay, the result of cecocolic hypermotility, are often found.

Gastric motility may be almost inhibited.

Non-retention of barium in the ileocecal region is found in late cases. In earlier cases this intolerance was demonstrated in Livermore's cases by roentgenoscopic palpation. Emptying of the cecum following its palpation was observed in other cases than tuberculosis, but only where organic pathological conditions existed. Palpation of the cecum if it contains barium will cause it and the ascending colon to empty distally.—*R. S. Bromer.*

Dzialoszynski, A. Differentialdiagnostik akuter chirurgischer Baucherkrankungen mit Hilfe des Röntgenbildes. (Roentgen differential diagnosis of acute surgical abdominal diseases.) *Deutsche med. Wchnschr.*, Oct. 11, 1929, *55*, 1713–1714.

Roentgen examination should be used more than it has been heretofore in the diagnosis of acute abdominal conditions in order to avoid exploratory laparotomy. Cholecystography has made exploratory laparotomy almost unnecessary in diseases of the bile tract.

It may be very difficult to make a clinical diagnosis of retrocecal abscess in stout patients but a barium meal or enema shows filling defects in the cecum which are smaller than those of tuberculosis. The defects are always limited to the cecum and generally to its lower part. The ascending colon is normal. Another acute condition in which roentgen examination is valuable is covered perforation of an ulcer of the stomach or duodenum. An ulcer that perforates into the free abdominal cavity can generally be diagnosed clinically. But the clinical symptoms are not so clear in covered ulcer. Roentgen examination shows an air bubble beneath one or both sides of the diaphragm. In the normal abdomen the upper border of the liver and the diaphragm form a single line but in perforated ulcer they are separated by air. There may also be a subphrenic gas abscess or an encapsulated abdominal abscess containing gas. A third acute abdominal condition in which roentgen examination is indicated is ileus. It shows a characteristic level of secretion in the meteoric loops with gas above it.—*A. G. Morgan.*

Vaughan, R. T., and Singer, H. A. The value of radiology in the diagnosis of perforated peptic ulcer. *Surg., Gynec. & Obst.*, November, 1929, *49*, 593–599.

This paper is based on 72 cases of ruptured gastric ulcer. All of these patients were subjected to roentgen examination to determine if pneumoperitoneum had occurred.

Sixty-three of the 72 patients were free from air in the abdominal cavity. Attention is called to the importance of posture of the individual in detecting pneumoperitoneum. The patient should be placed on his left side, right side uppermost since it is evident that air, if present in the stomach cannot escape into the abdominal cavity through the perforated ulcer unless it is brought in contact with the opening. If a patient maintains the right lateral position, pneumoperitoneum may not occur and the condition escapes detection. Of course if no air is present in the stomach, pneumoperitoneum cannot result, so the method cannot be absolutely diagnostic. The author has noted pneumoperitoneum following gun shot and stab wounds of the abdomen, as well as from rupture of carcinoma of the stomach, appendicial abscess and from rupture of typhoid ulcer.—*L. R. Sante.*

Kirklin, B. R. A roentgenologic consideration of duodenitis. *Radiology*, May, 1929, *12*, 377–381.

In 1921 Judd directed attention to duodenitis, a diffuse inflammation of the duodenum, with or without actual ulceration. His observations have been confirmed from the histopathologic standpoint by MacCarty, Konjetzny and Wellbrock. Kirklin reviews the findings in 45 cases observed recently at The Mayo Clinic. This series indicates that duodenitis is characterized roentgenologically by marked irritability of the bulb which tends to empty itself quickly but not completely. It is best recognized during the period of emptying; the bulb does not empty in a normal even manner, but a spastic, grossly deformed, skeleton-like cap is seen, although it may appear normal during the filling phase and while full. The deformity differs from that of typical ulcer in that its borders are less sharply defined, no marginal or central niche can be seen, and there is no gastric retention. Its positive distinction from frank ulcer is not yet feasible, and it might be confounded with reflex spasm of the

bulb, but it seems to warrant further study.—*J. D. Camp.*

LEDOUX-LEBARD, R., and CALDERON, GARCIA. Utilité de la compression, efficacité d'une technique simple dans le radio-diagnostic des lésions bulbaires et jéjunales. (Utility of compression; efficacy of a simple technique in the roentgen diagnosis of bulbar and jejunal lesions.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1929, *17*, 128–130.

As is known, different compression methods are used for the roentgenologic demonstration of duodenal lesions. The aim is to force the barium, which as a rule remains only for a short period within the duodenum, into the niche, diverticular dilatations, etc., thus rendering them visible both roentgenoscopically and roentgenographically. This is important especially in ulcerations of the duodenum or anastomosed jejunum which lie "en face" and which consequently would escape detection if one would pay attention only to the examinations "en profile."

The techniques used for the demonstration of the en face niche may be divided into several groups: (1) administration of small amounts of opaque substances of very thick or gummy consistency and manual palpation of the suspected area in different positions; (2) the direct introduction of opaque liquid media into the duodenum by means of the Einhorn sound; (3) the introduction of the opaque liquid by means of the sound in association with the introduction of air (pneumo-relief of Pribram), and (4) oral administration of opaque colloidal substances having a positive charge (Blühbaum, Frick and Kalkbrenner). This latter method, however, while of some advantage in the examination of the jejunum has given practically no results in the duodenum.

The author uses simple compression which may be applied in two ways: (*a*) either by placing the patient in abdominal decubitus and exercising slight pressure on the right side, or (*b*) by applying a graded local compression according to Berg. For this latter a lead cylinder or a large compressor such as applied in roentgen therapy is used. The important factor is that the compression is graded and that it is applied in a vertical position.

Two causes of error may occur in connection with these examinations: (1) the normal variation in the architecture of the duodenal folds may, in some instances, simulate a pathological condition, and (2) the sedimentation of the opaque medium may lead to faulty interpretation. Both these errors may be prevented by repeated examinations.—*T. Leucutia.*

GUTMANN, RENÉ A., and JAHIEL, RICHARD. Valeur diagnostique et signification de la niche dans l'ulcère duodenal "de face." (The diagnostic value and significance of the niche in duodenal ulcer "en face.") *Bull. et mém. Soc. de radiol. méd. de France*, April, 1929, *17*, 133–140.

The occurrence of so-called "en face" niche (Åkerlund) resulting from the localization of an ulcer on the anterior or posterior wall of the duodenum is now generally admitted. For the roentgenologic demonstration of this lesion one may use serial roentgenograms (of the duodenum) taken by the usual technique or roentgenograms taken by special techniques.

The special techniques were studied by Ledoux-Lebard and Calderon (see above abstract) in detail.

The appearance of the en face ulcer in the routine serial roentgenograms (of the duodenum) is characterized by the following factors: (1) The duodenal bulb shows a more or less regular contour with thickening of the marginal line on one side and thinning on the other and with occasional incisura or pedicle running towards the niche. (2) The niche itself is located in the center of the bulb and is well visible especially when the bulb is filled with a very thin layer of opaque medium. (3) The folding of the duodenal mucosa around the ulcer shows a peculiar arrangement, in a majority of the cases resulting in a concentric striation around the niche. (4) With few exceptions the duodenal bulb shows an entirely normal appearance. For this reason if the filling alone is taken into consideration the ulcer may be overlooked.

(5) While in gastric ulcer the niche is characterized by a constancy in the image in the serial roentgenograms, the duodenal ulcer may lead to a variation in the appearance of the niche in the different roentgenograms due to spasms. In this respect one may compare the niche to a "spasmodic well," the ulcer lying at the bottom of the well.

According to the authors' estimation the

visibility of the en face niche in several of the serial roentgenograms cannot be attributed to a compression produced by the patient lying on the stomach, as assumed by Ledoux-Lebard and Calderon, but must be the result of perilulcerous edema which takes the form of a lighter ring around the ulcer and is similar to the wall described by Bergmann and Berg for the ulcers en profile.

It is interesting that although topographically the majority of the duodenal ulcers lie en face, roentgenologically the majority of the ulcers detected appear en profile. There are two explanations for this apparently paradoxical behavior of the duodenal ulcers: (*a*) a large percentage of the en face ulcers localized near the borders of the duodenum appear, because of the tangential incidence of the roentgen rays, as niches en profile, and (*b*) that often pseudodiverticula near the borders are taken for a niche, while the true niches which are in the center of the bulb escape detection. In this manner, only the ulcers localized strictly to the midportion of the anterior or posterior wall of the duodenum and the ulcers without surrounding deformities (especially pedicles) are recognized in the roentgenogram as true en face ulcers.—*T. Leucutia.*

Hickey, P. M. Cancer of the lower end of the esophagus and cardiac end of the stomach. *J. Am. M. Ass.*, Nov. 2, 1929, *93*, 1356–1358.

A thick mixture of mucilage of acacia with barium is often more efficacious in the diagnosis of carcinoma of the esophagus than the thinner barium mixture. Attention is called to a method advocated by Wm. H. Stewart in which a sausage casing is filled with barium mixture and swallowed. This is said to produce nausea at times, and for that reason may be undesirable. The right oblique prone position described by Manges permits of a better distention of the esophagus with a longer delay before the opaque mixture passes on into the stomach.

Soft gelatin bougies have given success in the early diagnosis of carcinoma of the esophagus. Technique of making these is as follows:

Ordinary cooking gelatin is allowed to soak in cold water until it swells fully, after which it is rendered fluid by heating over a water bath. When the gelatin has become thoroughly liquefied, barium paste made by thoroughly mixing barium with a small amount of water is added and thoroughly stirred. The mixture of the liquefied gelatin and barium is then poured into a cup and allowed to cool. After the barium gelatin is thoroughly jellied, it is removed from the cup and with brass cork borers of varying diameter plugs are cut out of the gelatin. These plugs are from 3 to 4 cm. long and from 8 to 16 mm. in diameter.

The patient is then studied with the roentgenoscope as he swallows with the aid of water these gelatin bougies. If one becomes lodged, the heat of the body will cause it to soften after two to three minutes and the barium gelatin will pass down into the stomach. If there is a tendency for the barium gelatin plug to stick, it can be at once softened and dislodged with a drink of warm water. These barium gelatin bougies are easily swallowed by the patient and even slight projections into the lumen of the esophagus can be easily detected. It is of equal importance that a negative diagnosis can be made if the larger sizes are easily swallowed and pass uninterruptedly through the esophagus. Previous to their employment the author felt diffident in making a negative diagnosis for cancer.

This method is submitted as a contribution to the early diagnosis of cancer of the lower esophagus. If the gelatin plug sticks at any points, the size and contour of the esophagus above the point of constriction can be studied for a moment or so by giving the patient a thin mixture of barium. This thin mixture will fill the esophagus above the plug and even slight dilatation can be studied in this way. As a further refinement in their use, a piece of string can be threaded through the plug. To this string which is prevented from pulling out by a knot in the string with a small washer of thin wax paper, a small silk thread is attached. When the patient swallows this bougie, the plug may be observed in its passage down and may by tension on the thread be raised to points where further study is desired.—*L. R. Sante.*

Einhorn, Max. Carcinoma of the lower esophagus and upper third of the stomach. *J. Am. M. Ass.*, Oct. 26, 1929, *93*, 1279–1282.

This report is based on: 44 cases of cancer of lower third of esophagus; 40 cases of cancer of upper third of stomach, and 78 cases of be nign cardiospasm.

Ordinarily the diagnosis of esophageal cancer is easy—occasionally, however, the growth involves the esophageal wall without constricting it; under these circumstances its diagnosis becomes more difficult. Recourse may be had to other physical methods of examination: esophagoscope, auscultation for a swallowing sound, and aspirating bougie. The author has occasionally made the diagnosis by securing particles of necrotic material of the tumor from the olive cap of the aspirating bougie after its removal.

Carcinoma of the upper portion of the stomach on account of its inaccessibility may escape detection; it is usually demonstrated roentgenographically, but may be small and difficult to see. Occasionally even exploratory operation fails to disclose the growth. Persistent cardiospasm without organic lesion of the gall-bladder or appendix or some other demonstrable cause can be assumed to be due to malignancy.—*L. R. Sante.*

DWYER, MAURICE F., BLACKFORD, JOHN M., and TURNER, HENRY C. Gastric cancer. *J. Am. M. Ass.*, Nov. 9, 1929, *93*, 1456–1459.

The stomach is more frequently involved with carcinoma than any other organ in the body, and it is not often cured. The three most common lesions of the stomach and duodenum bear approximately the following ratio: gastric ulcer 1; gastric cancer 2; duodenal ulcer 5. One hundred cases of gastric cancer form the basis for this report.

Analysis of these cases is carefully considered as to first symptoms and signs of the disease to be complained of by the patient.

Any detailed study of the histories of patients suffering from gastric cancer rapidly brings out two distinct groups. The larger group does not give any history of stomach disturbances prior to the onset of the symptoms of cancer or the present complaint; while each case of the smaller group gives a history of long-continued gastric disturbances prior to the onset of the present symptoms.

The larger group of cases gives a history of any onset of symptoms so insidious that it is difficult to recognize the exact beginning. Yet the beginning is not remote and the progress of the disease has been rapid. Such patients usually state that there has not been any trouble with their digestion and they have enjoyed vigorous health. Their present increasing gastric symptoms have averaged only eight months.

The smaller group of cases gives a striking contrast in having a longer early history of gastric disturbances. The history of dyspepsia runs back over an average of ten years before the onset of the symptoms of cancer. The old history may suggest chronic cholecystitis, a functional type of hyperacidity, or other gastric disturbance, or a more or less typical syndrome of gastric ulcer. Approximately one-third of all cases presented such a history, and these have been carefully reviewed.

Summary. 1. Of 3,000 patients complaining of gastric symptoms, 3.6 per cent had cancer of the stomach.

2. Sixty-two per cent of the patients with gastric cancer described their earliest symptoms as pain, soreness on pressure, and 15 per cent vomiting or loss of appetite; 23 per cent did not believe that the stomach was the cause of their illness.

3. Seventy-five patients lost more than 20 pounds each before coming for examination, yet only 2 remembered loss of weight as an early symptom, and only 20 considered it a prominent symptom.

4. A gastric mass was complained of by the patient in only 6 instances, though 41 had a palpable mass present.

5. Sixty-two per cent did not give a history of stomach trouble prior to the onset of the cancer symptoms, yet this onset is so insidious that it is difficult to recognize the exact beginning. The average duration of their complaint was eight months.

6. The examination of the group of gastric cancer patients presenting short histories showed with a remarkable uniformity a total lack of hydrochloric acid and definite roentgen evidence of large filling defects.

7. The smaller group, comprising 38 per cent of the series, gives a striking contrast in having an early history of much longer duration. They gave histories of gastric disturbances averaging ten years before the onset of the symptoms of cancer.

8. Seventy per cent of the smaller group had free hydrochloric acid present, some in excess of the normal.

9. Eighty-three per cent of the patients presenting long histories and the presence of

free acid had the tumor located in the pyloric region, compared with 44 per cent of the group with short histories and absent free acid.

10. Proper interpretation of the roentgenologic examination of the stomach is the most important factor in the diagnosis or exclusion of gastric ulcer. The objective observation, however, must always be correlated with the clinical data, as other conditions may simulate the filling defects of cancer.—*L. R. Sante.*

Kornblum, K. The significance of small intestinal stasis. *Radiology*, July, 1929, *13*, 17–28.

The author has been able to distinguish between two main groups of cases showing small intestinal stasis. The first is that group which has received considerable attention from roentgenologists and which manifests what is commonly spoken of as "ileal stasis." The characteristics of this group consist primarily in a delay in the advance of the head of the opaque meal. At six hours this usually has extended only as far as the cecum, and occasionally the entire meal is in the terminal ileum, the loops of which are not distinguishable except by palpation, and are then often found to be of larger caliber than normally. Some of the more common causes are colonic stasis, adhesions, neoplasms of the large bowel, and external pressure from abdominal and pelvic tumors. Probably the most important single factor causing ileal stasis is adhesions resulting from inflammatory conditions of the appendix. The second group of cases showing small intestinal stasis differs markedly from the first. The advancement of the head of the opaque column is variable. The most striking feature is the variety of forms assumed by the intestinal shadow. The opaque material, while seen occasionally as one continuous shadow, is more frequently broken up into segregated loops, the masses varying in size, shape and caliber. Quite as significant is the finding of gas distended loops. Causes of stasis in this group comprise adhesions, subacute and chronic peritonitis from cholecystitis or perforated ulcer, ascites, tuberculous peritonitis, primary lesions of the small bowel affecting its lumen, metastatic malignant lesions, morphine, and purely nervous causes including fear. Kornblum particularly emphasizes the frequency of stasis from malignant metastasis to the peritoneum, and the low-grade peritonitis of a nonmalignant nature which commonly occurs with ulcerative and infected cancers of the stomach and colon.—*J. D. Camp.*

Dillenseger. Un cas de dextro-position du grêle et de sinistro-position colique (avec duodénum entièrement mobile). (A case of dextro position of the small and a sinistro position of the large intestine (with entirely mobile duodenum).) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1929, *17*, 119–126.

During the course of a barium meal examination a peculiar anomaly consisting in a dextro position of the small and a sinistro position of the large intestine was observed in a woman forty-five years of age. The woman had complained of pain in the epigastric region for a period of several years. The clinical examination indicated the possibility of duodenal ulcer. At the roentgen examination it was found that the duodenum was entirely mobile and that there was no evidence of any pathological condition.

The case is interesting since it represents a congenital anomaly. It is most probable that the usual torsion of the digestive tube was not completed beyond the first stage so that the small intestine remained in the right side and the large intestine in the left side of the abdomen. This also explains the total lack of fixation of the duodenum.—*T. Leucutia.*

Berg, Hans H. Ueber Diverticulosis des Dickdarms. (Diverticulosis of the large intestine.) *Deutsche med. Wchnschr.*, July 12, 1929, *55*, 1159–1161; July 19, 1206–1208.

Diverticula of the large intestine are frequent in elderly and obese individuals, particularly at the sigmoid flexure. In the great majority of cases they are of no importance but retention and the inflammation that results from it may cause a series of symptoms ranging from slight anomalies in evacuation to severe peritoneal conditions. The development of inflammatory pericolitic tumors possibly with hemorrhage and stenosis, often leads to cancer being suspected. A great majority of the cases of so-called sigmoiditis are due to diverticulitis, and so-called infiltrative colitis probably always is. It is very hard to diagnose this condition clinically but the roentgen picture is very

typical. Masses of contrast medium are retained in the diverticula after the intestine is emptied causing shadows, some of them spherical and the size of peas, some of them lunar or beaker-shaped or circular and some of them not very dense, depending on the degree to which the diverticulum was filled with feces before the barium was given, or whether the bottom of it filled with barium and feces entered on top of that. When the enema is given a peculiar transverse ribbing of the intestine is sometimes noticed even before the diverticula are seen. This is a manifestation of inflammation of the mucous membrane of the intestine. The ridges extend far into the lumen of the intestine and give it a fissured appearance. The degree of this change, in association with pressure pain and sometimes clinical signs such as fever and leucocytosis, shows the degree of inflammation. There may be delicate irradiating folds in the mucous membrane of a diverticulum but there are none at the base of it. Sometimes the diverticula collapse after the enema is emptied. So a study of the mucous membrane relief is of value in determining whether the diverticula are of no consequence or whether there is an inflammation that may become serious clinically.

Conservative treatment is successful in the majority of cases. Perforation and ileus as well as fistulas may necessitate surgical treatment. —*A. G. Morgan.*

GOSSET, LEDOUX-LEBARD and CALDERON, GARCIA. Les signes radiologiques de l'invagination intestinale chronique de l'adulte. (Roentgenologic signs of chronic intestinal invagination in the adult.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1929, *17*, 131–133.

The intestinal invagination occurring in infants or children is usually of the acute or subacute type necessitating immediate surgical intervention so that only subacute or chronic invaginations of adults come, as a rule, to roentgen examination.

Gueullette who recently collected 120 cases of intestinal invagination in adults found that the condition was recognized before operation in only 15 instances.

A case of chronic intestinal invagination is described in a man sixty-one years of age who developed three attacks of abdominal pain within a period of six months. The roentgen examination was made following the last attack. While the clinical examination failed to elicit the true nature of the affection, the roentgen examination revealed the typical picture of a ceco-ileo-colic invagination without strangulation. The case came to operation and it was found that there was an invagination of the cecum and ileum into the ascending colon due to a fungating tumor of the ileocecal valve. —*T. Leucutia.*

DILLENSEGER. Un cas d'helminthiase intestinale. (A case of intestinal helminthiasis.) *Bull. et mém. Soc. de radiol. méd. de France*, April, 1929, *17*, 118–119.

In a case of intestinal helminthiasis observed by the author the roentgenogram of the colon taken following the administration of a barium meal revealed a vermiform opacity about 10 cm. long. Ultimately it was found that the shadow was due to the absorption of the gelobarium by an ascaris worm.

A review of the literature revealed that Fritz reported about 30 similar cases in some of which the movement of the ascaris worms could be plainly seen under the roentgenoscope.

The administration of a barium meal in case of ascaris worms is interesting not only because of its diagnostic possibilities but also on account of its therapeutic value.—*T. Leucutia.*

RANKIN, F. W. Surgical procedures in carcinoma of the rectum. *Radiology*, September, 1929, *13*, 207–210.

The author notes that at the Mayo Clinic the cases of carcinoma of the rectum are arbitrarily divided into two distinct groups, the operable and the inoperable, the former being recommended for surgery, the latter for palliative operation, radium and roentgen ray, or irradiation alone. The presence or absence of metastasis and the degree of malignancy as graded after Broders' method, affect the result from either procedure. In a large series of cases, when metastasis was present, operation yielded good results in approximately 20 per cent only; when it was absent operation was effective in more than 57 per cent. The results obtained in cases in which malignancy was graded 1, with metastasis, were almost as good as in cases in which malignancy was graded 3 and 4, without metastasis. The average duration of life after

operation decreased as the grade of malignancy increased. Grading of malignancy aids in the selection of cases for treatment by operation or radium or both. Malignant growths of grade 3 or 4 are more radiosensitive than those graded 1 and 2.—*J. D. Camp.*

Geling, J. Weiterer Beitrag zur Verbesserung der röntgenologischen Darstellung der Gallenblase. (Improvement in roentgen demonstration of the gall-bladder.) *Deutsche med. Wchnschr.*, July 19, 1929, *55*, 1220–1221.

Experiment has shown that iodtetragnost is decidedly hepatropic, that is, that it is carried to the liver and stored there. It is then eliminated from the liver through the bile tract. The author therefore tried to improve the roentgen demonstration of the gall-bladder by giving tetragnost and then giving decholin, which is a cholagogue. Intravenous injection of 20 per cent decholin increases the amount of bile to four or five times what it was before. The author found that the gall-bladder shadow could be demonstrated four to five hours after tetragnost injection. This shortens the time the patients are obliged to go without food. The results prove the author's theory in regard to the circulation of pigment and also show the excellent cholagogic action of decholin. Experiments were also made with the oral method, but the results were not the same. Sandström's is the best of the peroral methods but even it does not give as good results as intravenous injection.—*A. G. Morgan.*

Brockmann, F., and Schenck, V. Oral-Tetragnost, ein neues Präparat zur Darstellung der Gallenblase im Röntgenbild. (Oral-tetragnost, a new preparation for demonstrating the gall-bladder in roentgenograms.) *Deutsche. med. Wchnschr.*, Aug. 16, 1929, *55*, 1380–1381.

As the intravenous injection of tetragnost sometimes has bad by-effects such as collapse and inflammatory thromboses of the arm veins, efforts have been made to find a good oral method and to avoid the disadvantages of giving the preparation in capsules. This has been accomplished to a very great extent by oral-tetragnost, which is a combination of tetraiodophenolsulphonphthalein sodium with fruit acids. It is so effective that the author thinks it will to a certain extent supplant the intravenous method. It is absolutely free of danger and very much superior to the capsule method. The intravenous method is still more reliable, however, and gives clear pictures in some cases in which the oral method gives none or incomplete ones. The author thinks the best way is to give oral-tetragnost first; if the results are negative the intravenous method can then be used, though it is better to wait a few days and in the meantime empty the intestine thoroughly.—*A. G. Morgan.*

Blond, Kaspar. Über ein bisher nicht beachtetes Symptom bei der Cholecystographie und seine klinische Bedeutung. (A new symptom in cholecystography and its clinical significance.) *Klin. Wchnschr.*, Aug. 20, 1929, *8*, 1572–1573.

On taking a picture of the gall-bladder region twelve hours after intravenous injection of the usual contrast medium the author found that in addition to the gall-bladder shadow there was a deposit of the contrast medium in the large intestine at the hepatic flexure. This deposit at the hepatic flexure could only have come from the liver through Vater's papilla, as the contrast medium had been injected. Since then he has seen this deposit in cases when the contrast medium was given intravenously, no matter whether the gall-bladder was filled or not. In reviewing the cholecystograms of other authors he has also found it though no attention has been paid to it before.

He concludes from this symptom that the liver is discharging bile into the intestine all the time, day and night, so that the usual theory that there is an antagonism between the musculature of the gall-bladder and Oddi's sphincter is false. The presence of the deposit in the intestine serves as a liver function test, at least with regard to the excretion of dye. From the point of view of diagnosis a normal gall-bladder shadow and a normal intestinal deposit shows that Vater's papilla is permeable and both stone and scar of the hepatico-common duct can be excluded. If there is a faint gall-bladder shadow and a large intestinal deposit it shows injury of the absorptive capacity of the gall-bladder mucous membrane, or increased rapidity of retrograde absorption or relative stenosis of Heister's valves, or pathological dilatation of the hepatico-common

duct. If there is no gall-bladder shadow and there is a deposit it shows permeability of the hepatico-common duct and disease of the gall-bladder.

The question still remains why, if bile is being continuously discharged from the liver into the intestine, a part of the contrast medium enters the gall-bladder? The author decides that it is by virtue of the absorptive capacity of the mucous membrane of the gall-bladder, a hydrodynamic force which constantly draws bile from the hepatico-common duct into the reservoir. This is the only way to explain why bile constantly flows through the papilla and at the same time is drawn into the gall-bladder and stored there.—*A. G. Morgan.*

GYNECOLOGY AND OBSTETRICS

RONNEAUZ, GEORGES. Grossesse extra-utérine rompue, arriveé à terme. (Ruptured extrauterine pregnancy coming to term.) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1929, *17*, 111–113.

A case of an extrauterine pregnancy is described in a primipara twenty-eight years of age who at three months suddenly experienced very intensive abdominal pain lasting for a period of several days, after which everything returned to normal. The pregnancy continued and the patient was examined when nearly at term. The roentgen examination showed an abnormal position of the fetus which was interpreted as being due to a large uterine fibroid located in the lower segment of the uterus. The patient came to operation and surprisingly it was found that there was an abdominal pregnancy. The living fetus lay free in the abdomen between the loops of the small intestine, epiploic adhesions having formed around the left end. Unfortunately both mother and child died within one day following the operation.

The case is exceedingly rare and is reported on this account. The opinion is expressed that the asymmetric position of the extremities of the fetus might have suggested an abdominal pregnancy preliminary to the operation. At any rate its possibility should have been mentioned to the operative surgeon.—*T. Leucutia.*

GENITOURINARY SYSTEM

STEVENS, WILLIAM E., and HENDERSON, J. G. Urology in women and in gynecology. *J. Am. M. Ass.*, Oct. 26, 1929, *93*, 1282–1287.

Attention is called to the large number of women giving symptoms referable to the urinary tract. Of the last 8,302 patients admitted to the Women's Clinic at Stanford University School of Medicine, 824, or 9.9 per cent, were referred to the female urological service; this was exclusive of gonorrhea cases. These were due to a large variety of causes which are briefly enumerated. Pressure of the fecal head during pregnancy is responsible for many cases of hydronephrosis and pyelitis, and pyelograms of this condition are shown. Tuberculosis of the kidney during pregnancy is surprisingly rare—only one case has been found in 5,435 patients admitted to the obstetric division.

Four-fifths of cases of ptosis of kidney were found in women. It is most frequently found on the right side and at times gives very grave symptoms.—*L. R. Sante.*

COTTENOT, and BINET DU JASSONEIX. Un cas d'opacité totale des vésicules seminales. (A case of total opacity of the seminal vesicles.) *Bull. et mém. Soc. de radiol. méd. de France*, March, 1929, *17*, 109–110.

The authors observed a total opacity of the seminal vesicles in the roentgenogram of a man sixty-two years of age. Two hypothyses are advanced for the explanation of this curious phenomenon. Either there is evidence of numerous small calculi filling both seminal vesicles or the calcifications are secondary to tuberculous lesions. This latter appears the more probable.—*T. Leucutia.*